THE AEROPLANE

Incorporating
Aeronautical Engineering
Edited by - - THURSTAN JAMES

Founder and First Editor
(1911-1939), C. G. GREY

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GOING BACK TO UNSOLVED PROBLEMS

DISAPPOINTMENT will be widespread that the Juno rocket launched by the United States Army did not succeed in breaking out of the Earth's gravitational field. It seems that this job of attaining escape velocity is somewhat more difficult than the various protagonists in these efforts have been leading people to believe. Yet the very disappointment is a measure of the progress which has been made in the year since the first Sputnik was successfully launched. The subsequent spate of satellites had got people used to the idea of sending up objects into orbit so it began to be assumed that the next stage of breaking out into space would be achieved according to programme. However, once the imagination has been fired to such efforts there are always people pressing forward with new ideas and in this issue a contributor writing about the failure suggests that the British Blue Streak might succeed where others have failed.

While we were studying the latest news on this matter our attention was sharply recalled to Earth by a report from Belfast that a lecturer in aeronautical engineering at Queen's University, Belfast, is working on the design of a new aircraft intended to be driven by muscle power only. He is being assisted by five fourth-year students. This message served as a reminder of the vast range of the aeronautical sciences and also perhaps more pertinently as a reminder that man has plenty of problems still to solve; problems which in many cases he by-passed as being too difficult and then went on to solve more spectacular ones.

Current controversies about runway lengths and take-off paths provide an example of how in aviation we have by-passed the problem of getting on and off the ground slowly. In order to achieve very high cruising speeds very light wing loadings have given way to very heavy ones. Devices for increasing lift have been used to put up wing loadings instead of reducing landing and take-off speeds. It is a sobering thought to consider what might be achieved in the way of improving air traffic handling if we went back to the alighting and take-off speeds normal at the beginnings of commercial aviation. All the time we are being pushed to the development of new devices to deal with higher take-off speeds and longer runways.

For over 30 years man has been demonstrating, with increasing skill, his ability to extract sufficient energy from the atmosphere to sail a fixed-wing unengined aircraft over distances and up to heights that would be regarded by the pilots of powered aircraft as a creditable achievement. Originally using the combined muscle power of a team of fellow enthusiasts, the sailplane pilot of today relies on the power of an internal combustion engine to winch him into the air or to tow him behind an aerial tug. So we are in the curious position that though man can rise to heights of 50,000 ft. with no engine at all and travel through the air without power for hundreds of miles, the World has yet to wait for a demonstration that one man, or a team of men, can first get an aircraft with himself, or themselves, aboard, into the air and then to maintain height in such conditions that it is clear that the aircraft is supported by muscle power alone.

If anybody doubts that framing the necessary conditions is a complicated business they have only to turn up and study the widely disseminated correspondence which has taken place during the past year on the subject of the early attempts at flight made by the late Colonel S. F. Cody and Mr. A. V. Roe (as he was at the time). The establishment of precise conditions is important because no one supposes that any spectacular break-through is to be expected. Both Nonweiler and B. S. Shenstone, who was an earlier writer in this field, agree that it will indeed be an achievement to get the muscle-powered aircraft as high as 25 feet above the ground and to fly for half a minute. Such a short expectation arises from the fact, which we all know too well, that man is capable of his maximum effort only for very short bursts indeed.

It seems that the Nonweiler project will have to wait for funds before building can be started. In this connection it is good to know that the Council of the Royal Aeronautical Society have given their approval to the formation of a Man-power Flight Group within the Society. Such an organization should provide an ideal means of banding together all those who are interested in the problem and wish to make their own personal contribution according to their interests and means. Moreover, at this stage lectures and discussions would be profitable, particularly were they to be organized in the provinces.

Let us hope that the new Man-power Flight Group of the R.Ae.S. will be able to get some student groups working in competition with the Nonweiler team. We suppose it is too much to hope that the Air League could re-apply the funds earmarked for the R.34 Memorial to this purpose, but we are sure that the pioneers who crossed the Atlantic in her would approve such encouragement to a new breed of pioneers.

MATTERS OF MOMENT

M.o.S. Missile Men

NEW appointments, significant of the emphasis being placed on the guided weapons programme for the Services, have been announced by the Ministry of Supply. They become effective early in the New Year.

A new post of Director-General, Ballistic Missiles, has been created and is to be filled by Mr. William H. Stephens, M.Sc., F.R.Ae.S., who is aged 45. He has been Deputy Director of the Royal Aircraft Establishment at Farnborough since 1956.

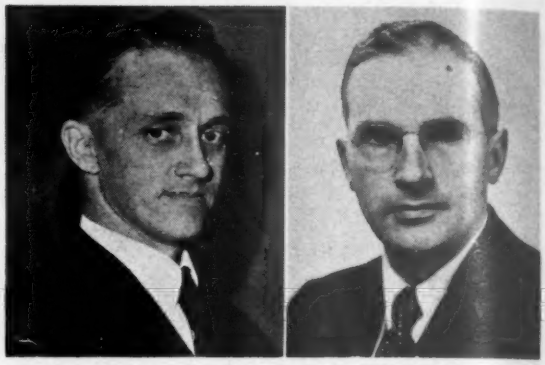
He joined the R.A.E. in 1935, and for two years was engaged on rocket research with the Ballistics Division at Woolwich. From 1939 to 1943 he was with the Air Ministry and the Ministry of Aircraft Production; later he was Assistant Director, U.K. Scientific Mission, in the British Commonwealth Scientific Office in Washington, and Assistant Scientific Attaché at the British Embassy there. In 1947 he was appointed superintendent of the Assessment Division of the R.A.E. Guided Weapons Department, and from 1954 to 1956 headed the Guided Weapons Department.

Mr. Stephens is to be succeeded as Deputy Director of the R.A.E. by Mr. Samuel F. Follett, B.Sc.(Eng), M.I.E.E., F.R.Ae.S., at present Director-General, M.o.S Staff, with the British Joint Services Mission in Washington. Now aged 54, Mr. Follett went to the Electrical Engineering Department of the R.A.E. in 1927. From 1946 to 1950 he was Assistant Director of Instrument Research and Development (Electrics), and for the next four years was Director of Instrument Research and Development, M.o.S. He then became Principal Director of Equipment Research and Development, and in 1956 was appointed Deputy Director-General of Aircraft Equipment Research and Development.

Succeeding Mr. Follett as Director-General, M.o.S. Staff, B.J.S.M., in Washington, is Mr. L. T. D. Williams, B.Sc., A.R.C.S. Born in 1905, he joined the Chemical Defence Experimental Establishment in 1925, moving in 1939 to the Division of Chemical Defence Research and Development. From 1943 to 1945 he was with the B.C.S.O. in Washington, and for the next two years was Deputy Head of the Chemistry Section, Chemical Defence Experimental Establishment, at Porton.

In the following year Mr. Williams was acting Head of the Chemical Section, M.o.S., and for three years from 1951 was that department's Superintendent. His last appointment was as Chief Superintendent, Explosives Research and Development Establishment, at Waltham Abbey, and he is at present taking a course at the Imperial Defence College.

Mr. J. H. Phillips, B.Sc., A.M.I.E.E., F.P.S., aged 49, has been appointed Director, Guided Weapons (Techniques). In 1939 he joined the Bawdsey Research Station (which was the origin of the Royal Radar Establishment) as a Scientific Officer He was in Washington with the British Supply Office from 1945 to 1947, and thereafter, for four years, was at the Guided Weapons Department of the R.A.E. He was at the Headquarters of the Guided Weapons Research and Development Department, M.o.S., from 1951 to 1957, when he went to the B.J.S.M. in Washington.



MEN IN THE NEWS.—Left, Dr. D. B. Spalding, M.A., Ph.D., A.M.I.Mech.E., A.M.Inst.F., appointed to the new chair of Heat Transfer at Imperial College. Right, Mr. W. H. Stephens the new Director-General, Ballistic Missiles, at the Ministry of Supply.

Lunar By-pass Still Unopened

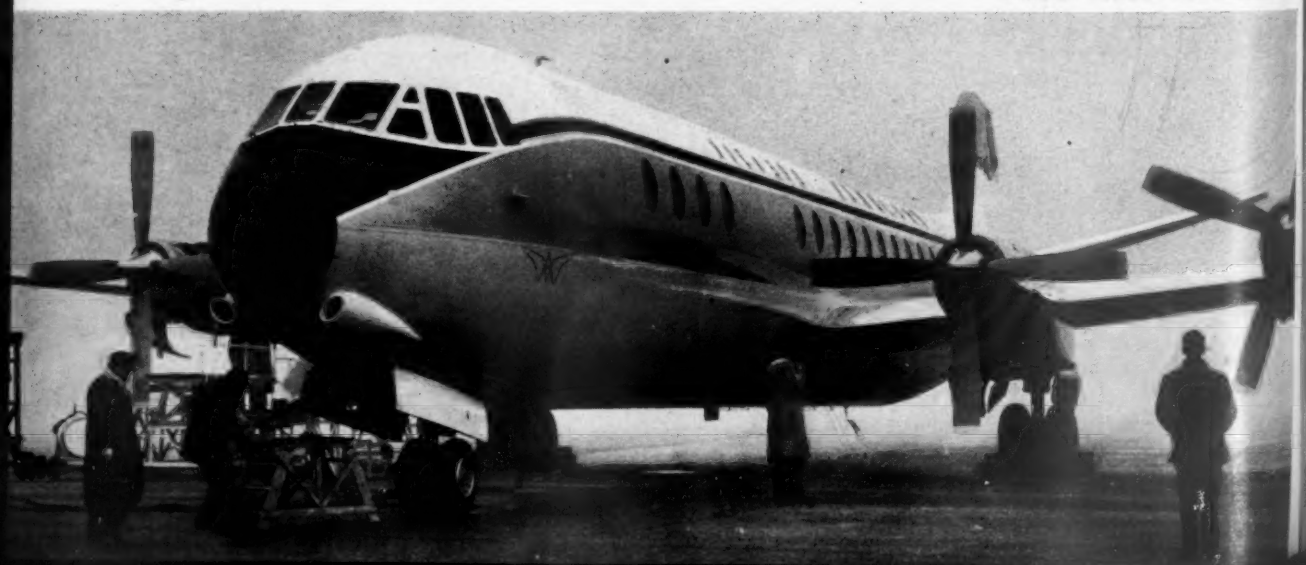
LAST week's unsuccessful bid by the U.S. Army Ballistic Missile team to launch a lunar probe past the Moon has caused some people to revise their ideas about the feasibility of forwarding probes to Mars and Venus next year. In fact it is beginning to look as though the standard IRBM hardware (Thor or Jupiter) has not quite the capacity to do the job, or, if it has, the margin is extremely small. Here is a chance for a long-range Blue Streak to show its paces, though it will need a Titan, an Atlas or a Sputnik III launcher to lift anything worth while against the burden of Earth gravity.

The Juno II four-stage launching vehicle that was tried for the first time against a celestial target consisted of a modified Jupiter IRBM, fitted with elongated tanks to increase the burning time to 118 seconds. Surmounting the standard guidance compartment in the nose cone were 15 solid-propellent Sergeant rockets, staged in clusters of 11, 3 and 1, each of which fired for 6½ seconds. During the initial boost period these clusters were protected against atmospheric heating by an ablative nose cover that was jettisoned just prior to first-stage burn-out.

The overall concept of Juno II's design was to sacrifice

NEARLY READY.—The first Vickers Vanguard was rolled out of the final assembly shed at Weybridge on December 4 for engine runs and adjustments prior to the first flight—which should take place before Christmas.

Photograph copyright "The Aeroplane"



WORLD TOUR.—Air Marshal Sir Andrew McKee, A.O.C.-in-C., Transport Command, with members of his aircraft's crew on the completion of his round-the-World flight in a D.H. Comet 2 of No. 216 Squadron last week. Commanded by Sqn. Ldr. N. Taplin, the Comet covered some 32,000 miles in a flying time of 72 hr.

sophistication for simplicity, unlike the three Air Force lunar probes that were intended to circumnavigate the Moon and even attempt to scan its surface. The Army's probe was to head straight for the Moon, either by-passing it or impacting somewhere, nobody cared which.

To avoid errors of course deviation during first-stage guidance, the internal system was monitored by Doppler radio link, watched over by a ground station. Somewhat hopefully the chances of success were rated as high as two to one.

The 13-lb. instrument payload had been trimmed to a bare minimum. Apart from a miniature radio transmitter, the payload included only two radiation counters set up to pick up different ranges of energy at a different counting rate.

As the probe's lifetime was expected to be short, batteries of limited operational life were fitted. There was no retro-rocket or TV scanner, though a photo-electric optical device was added for obtaining test data that might be used for a picture scanning device in future probes.

In the event, Juno II reached a speed of something less than 23,000 m.p.h., which resulted in an apogee of only 65,000 miles before turning back. (Pioneer II achieved an apogee of 79,000 miles for a speed of 23,300 m.p.h.)

It was stated later that if the first stage had continued burning for another 3.7 seconds the project would have been successful. Either there must have been a miscalculation, or a premature cut-off, for 24,300 m.p.h. had been stated earlier as the expected burn-out velocity; though to escape Earth gravity entirely and go into orbit round the Sun requires a terminal velocity of 25,500 m.p.h. This now appears to be impossible with the present rocket configuration.

To track the probe in space the Americans had to rely entirely on their own quite adequate facilities. A last-minute fault in some U.S. equipment supplied for the Jodrell Bank telescope prevented this from going into action.

The U.S. Army's new 85-ft. diameter parabolic antenna at Goldstone, in the Mojave Desert, is believed responsible for the initial tracking. It is reputed to have a range of 400,000 miles at the moment, a figure that will be extended to 40 million miles by 1960, and 4,000 million miles by 1962. It might be needed for tracking a Martian Probe (due to leave in March, 1959) or the Venus Probe (January, 1960), but in the meantime the next lunar probe launching is not expected to take place before February, 1959—unless the Russians have other ideas.—J. G. WHY.

Noise in the House

THERE was a debate on December 5 in the House of Commons on the problems associated with living and working near military aerodromes. MR. BRIAN HARRISON (C., Maldon) introduced a motion calling on the Government to do everything possible to reduce the inevitable disturbance and ensure that compensation claims for damage were dealt with fairly and promptly.

MR. FRANK BESWICK (L., Uxbridge) said that it might be feasible to have silencers fitted to military aircraft when on non-operational work; these could be removed when required.

MR. CHARLES ORR-EWING, Under-Secretary of State for Air, said that there was no tendency in the Air Ministry to underestimate the noise that people had to suffer. It had proved impossible to fit the silencers developed for civil aircraft to military types.

Discussing supersonic bangs, Mr. Orr-Ewing said that supersonic flying over land was forbidden except on specific authority from the Air Ministry, and was never allowed below 30,000 ft. For training purposes supersonic flights were made over the sea with aircraft pointing away from the land.

Most supersonic test flying of aircraft under the control of the Ministry of Supply was made over the sea. But it was sometimes essential for development aircraft to be flown supersonically over land; only in exceptional circumstances was this done below 30,000 ft. But with modern aircraft it was impossible to eliminate the likelihood of a pilot breaking the sound barrier inadvertently.

Dealing with compensation, Mr. Orr-Ewing said claims for damage by sonic bangs were dealt with entirely on their merits. In the past two years there were 824 claims and 221 payments had been made. More than £2,000 had been paid out, about a third of which related to unidentified bangs.

Heat Transfer Activities at I.C.

ON December 2 in London at Imperial College Dr. D. B. Spalding, who has recently been appointed to the new chair of Heat Transfer in the Department of Mechanical Engineering, read his inaugural lecture on "Heat Transfer in Rocket Motors." As the professor explained in his lecture, heat transfer is the process which occurs when two objects of different temperatures interact. It is also the branch of science which deals with the rate of such interactions in an engineering situation. For example, the successful operation of a rocket motor depends on keeping these processes under close control.

Heat transfer is a practical subject, the professor pointed out, and exists so equipment may be designed and developed more successfully and cheaply. Indeed, it will continue to be studied as long as temperature and composition differences continue to lie at the root of all man's activities.

Imperial College has a long tradition, not only of heat transfer research but also of efforts to present its results in a form which can be understood and used by engineers in industry. This tradition, the new professor undertook, would be continued by research, and through the new post-graduate course in heat transfer and combustion.

Last Supermarine Aircraft

NO new Supermarine aircraft will be designed following the Vickers-Armstrongs decision to concentrate the design and development of new aircraft at their Weybridge factory. The long line of Supermarine designs, which reached its peak of fame with the Spitfire, has come to an end with the Scimitar.

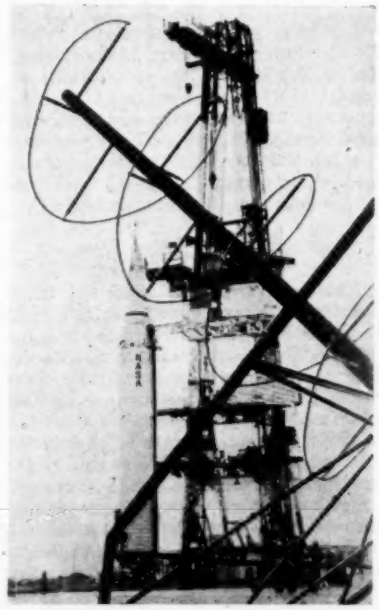
The Supermarine design team has been split up; some of its members have gone to Weybridge, where their experience of supersonic aircraft should prove useful, and the rest are at the Supermarine works at South Marston, near Swindon. Here part of the team is responsible for work on the Scimitar, whose production will probably end in 1960, and the rest will work on the design of nuclear and industrial equipment.

Although the South Marston factory will continue with sub-contract work for aircraft, its efforts will be gradually transferred to nuclear and general engineering. Research and training reactors suitable for technical colleges and universities will be designed and built, but the company will not produce power or propulsion reactors.

U.K. ARRIVAL.—One of the McDonnell F-101A Voodoo all-weather fighters of the U.S.A.F. which arrived at Bentwaters last week (see this page).

News of Aircraft, Engines and Missiles

BLUE STREAK FIRINGS.—Test firings of the Blue Streak LRBM may begin before the end of 1959. Two launching sites are being built in natural gullies 30 miles west of Woomera. Initial firings will probably be over the 1,250 miles between these sites and an area just inland of Port Hedland, Western Australia.



LUNAR PROBE.—Juno II in the launching gantry at Cape Canaveral (see page 840); a tracking antenna is in the foreground.

VOODOOS ARRIVE.—Last week the first batch of McDonnell F-101A Voodoos of the U.S.A.F. arrived in Britain to replace the 75 Republic F-84Fs of the 81st Tactical Fighter Wing, which has its H.Q. at Bentwaters, Suffolk. The Voodoos flew the 5,500 miles from Shaw A.F.B., South Carolina, in about 10¼ flying hours with one intermediate stop at Nouasseur, Morocco. They were twice refuelled in the air on the first leg, but the 1,380 miles from Morocco were flown without refuelling. The Voodoo has been in service with Tactical Air Command since May, 1957. Some of the F-84Fs which it is replacing are going to the Luftwaffe.

CLIPPED GANNET. — During a recent training sortie in a Fairey Gannet of No. 719 anti-submarine training squadron from Eglinton, Lieut. E. S. E. Taylor flew through the slipstream of another Gannet while in a 40° dive to fire rocket projectiles. In the resultant evolutions, Lieut. Taylor's aircraft pulled 8-9 *g* and lost both outer wings and ailerons. That the pilot was able to regain control with the assistance of rudder and land back at Eglinton at 125 knots without further damage is a remarkable tribute both to fine airmanship and the structural integrity of the Gannet, which survived nearly twice its designed load factor.

RUSSIAN RECORDS.—New "load-to-height" records are claimed for an Ilyushin Il-18, which on November 17 carried a load of 5 tons to 13,274 m. The aircraft was piloted by Vladimir Kokkinaki. Two days previously 10 tons had been lifted to 13,154 m., and 15 tons to 12,171 m. on November 14.

M.L. AFFAIRS.—Because of the increased activity and turnover of M.L. Aviation and M.L. Engineering during the past few years, these companies have been turned into a public company. M.L. Holdings, Ltd., has been formed as a non-trading company with a capital of £500,000 in 5s. shares. Its subsidiaries will be M.L. Aviation as research design and development engineers and M.L. Engineering undertaking production. There are no changes in the management of these two concerns.

GERMAN FIRST. — The Baade 152 four-jet transport built by the East German state-owned factory in Dresden made its first flight on December 4.

VANDENBERG LAUNCHINGS.—Satellite launchings from Vandenberg A.F.B., Calif., may be made monthly during 1959 for a programme known as "Project Discover"; this is aimed at putting a manned vehicle in orbit. All launchings will be made towards the South Pole. The first satellites will be launched by a Thor IRBM plus a second stage, but later launchings will use the Atlas ICBM plus a high-energy second stage which should put a satellite weighing up to 10,000 lb. in orbit. The satellites will carry mice and monkeys.

NEXT WEEK

BRITAIN'S newest airliner the Vickers Vanguard (Rolls-Royce Tyne turboprops) will be fully described and illustrated in the issue of THE AEROPLANE dated December 19. Features will include a pull-out cutaway drawing by J. H. Clark.

Other exclusive articles along with regular features and news will also be included.

The cost of this issue will be the usual 1s. 6d.; it can be obtained from all newsagents and booksellers, or direct from the publishers, Temple Press Limited, Bowling Green Lane, London, E.C.1, for 1s. 10d.

FRENCH ROTORCRAFT.—Ground testing of the SE.3200 20-28-seat helicopter powered by three turbines will be completed this month. First flight tests are to be made early next year.

EMPIRE TEST PILOTS SCHOOL
McKENNA DINNER
DECEMBER 4, 1958
AS LAST YEAR, FOG ELIMINATED SOME OF THE GUESTS, BUT NOT JOHN CUNNINGHAM WHO, NAVIGATING FOR AN INSTRUMENT-RATED D·H CHAUFFEUR, STRUCK A NICE BALANCE BETWEEN AN ARBITRARY E.T.A. AND A SHIFTING POINT OF NO RETURN.
— NOR DID IT IN THE LEAST DISCONCERT "HP" TO WHOM NATURAL FOGS ARE PRETTY THIN STUFF WHEN COMPARED WITH SOME OF THE GOVERNMENTAL FOGS HE'S PENETRATED
"A test pilot has to have the courage of somebody else's convictions"
GP. CAPT. R.E. "PADDY" BURNS E.T.P.S. Commandant
Air Chief Marshal SIR CLAUDE PELLY Controller of Aircraft, M.o.S. PRESENTED THE McKENNA TROPHY TO
Flt. Lt. CHANDU GOLÉ Indian Air Force WHO TOPPED No. 18 COURSE.
Flt. Lt. ALAN GODFREY Asst. Flying to Mess Sec.
Lt.-Col. P.M. "SHEEPY" LAMB MADE HIS FIRST APPEARANCE AS SAUNDERS ROE'S CHIEF TEST PILOT
Capt. UMBERTO MUSCANTI Italian Air Force
Flt. Lt. BOB WHYTE FIRST WINNER OF THE NEW EDWARDS AWARD, FOR MAKING THE MOST PROGRESS
Wg. Cdr. E.H. "TOPSY" TURNER Chief Test Flying Instructor
Lt. PAUL MILLS CARRYING THE EDWARDS
THE EVENING'S ACTIVITIES INCLUDED A TUG-OF-WAR TWEEN E.T.P.S. AND THE CIVIL TEST PILOTS: THE INDUSTRY LOST IN SPITE OF PULLING SO WELL TOGETHER.
— IT WAS A GOOD

News About People—

BRAINS TRUST.—Under the chairmanship of Mr. E. Colston Shepherd, a team consisting of Mr. Peter Masefield, Sir Arnold Hall, Mr. Robert Lickley and Mr. Peter Brooks will form a Brains Trust panel at a meeting of the Aircraft Recognition Society on December 17. It will be held in the R.Ae.S. library at 19.00 hrs. The Society extends an invitation to readers of THE AEROPLANE to attend.

GOODYEAR MANAGER.—Mr. T. F. Minter is now manager of the Garscadden, Glasgow, factory of the Goodyear Tyre and Rubber Co. (Great Britain), Ltd., in succession to Mr. M. S. MacDonald, who has returned to the U.S.A.

FROM THE MIDDLE EAST.—Mr. B. G. Barnard, who has been civil air attaché in the Middle East since 1948, is returning to the U.K. early next year to take up special duties with the Ministry of Transport and Civil Aviation in a position in which his long experience of Middle Eastern affairs will be particularly valuable.

TRIPLEX RESEARCH.—Mr. John Page has joined the research staff of the Triplex Safety Glass Co., Ltd., at King's Norton, Birmingham. He will be connected with all projects dealing with safety glasses for the aircraft industry.

TAKING SHAPE.—In the final assembly shop at Northrop Aircraft are T-38 supersonic basic trainers (two G.E. J85 turbojets), brothers of the N-156 fighter. The T-38, for which the U.S.A.F. has recently placed a production order, is one-third to one-half lighter than any other aircraft of comparable performance.

B.E.A. APPOINTMENTS.—Mr. A. E. Pigg, previously B.E.A.'s manager for France, has been appointed regional manager at head office following the impending retirement of Mr. W. C. Gaskin. Mr. A. C. Mills has been appointed sales manager in Canada from January 1, and will be based in Toronto; Mr. Mills was previously contract sales superintendent and joined the Corporation in 1946.

P. F. BRYAN.—We are sorry to record that Mr. P. F. Bryan, A.F.R.Ae.S., manager of de Havilland's aircraft design division, died on December 3. He was 55, and had been with the company for 25 years. He was apprenticed to the Air Navigation and Engineering Co., Ltd., 1920-25, and worked under Mr. W. S. Shackleton on the A.N.E.C. monoplane. He subsequently went to Beardmores, and worked on the Wee Bee, then to Bristols, employed on engines, and in 1925 was appointed chief draughtsman of the Larkin Aircraft Co., Ltd., in Melbourne. On returning to the U.K. he was associated with the design of the Shackleton-Murray S.M.1 light pusher monoplane. He joined de Havillands in 1933 and seven years later was appointed chief draughtsman.

APPRENTICE SCHOOL.—On December 2 Lt.-Gen. Lord Weeks, a director of Vickers, Ltd., opened the new apprentice school at the Supermarine works of Vickers-Armstrongs (Aircraft), Ltd., and presented prizes. Here, Mr. B. J. Lawford receives his award from Lord Weeks, behind whom is Mr. J. W. Jennings, deputy company education officer. At table (right to left), are Mr. H. H. Gardner, director and chief engineer, military aircraft, Mr. J. H. Robbie, director and controller of finance, Mr. T. Gammon, deputy managing director, and Mr. S. P. Woodley, director and managing director, Supermarine works.

Photograph copyright "The Aeroplane"

Commercial Aviation Affairs

CHEAPER FERRY.—Substantial fare cuts in Silver City's vehicle ferry services were due to be announced on December 11. The reductions apply to the services between the U.K. and France and Belgium. This is the ninth Silver City fare-reduction in its 10 years of operation, and the cuts are designed to benefit the owners of smaller motor cars, which will be charged up to 27½% less than last year.

U.K. NAVIGATION. — Following evaluation trials the M.o.S. has ordered 11 complete Marconi VHF Omni-directional Radio Range (VOR) installations on behalf of the M.T.C.A. These installations will be located at selected points on the U.K. airways network to provide an overall VOR navigational system.

JETSTAR APPROVED.—The Lockheed Jetstar has been approved for operation at Idlewild following noise tests by P.N.Y.A. engineers with the Orpheus-engined prototype at Marietta. Both prototypes of the Jetstar are fitted with the Lear L-102 lightweight autopilot which provides facilities for altitude control, automatic heading, Mach hold, altitude hold, altitude selection, VOR and ILS.

COMET PLANS.—B.O.A.C. plan to introduce Comet services as follow: May, 1959, to Tokyo; July, 1959, to Hong Kong; Sept., 1959, to Singapore; Dec., 1959, to Australia; Jan./Feb., 1960, to Santiago; Feb., 1960, to Johannesburg; April, 1960, to Salisbury.

T.W.A. STRIKE ENDS.—Mechanics of the I.A.M. accepted an offer from T.W.A. on December 7 and returned to work on the following day after a strike lasting 16 days. Eastern Airlines continues to be strike-bound at press time. Although a judge had ruled that the flight engineers could not legally strike against the airline's decision to use only pilots on the flight decks of jet aircraft, they said other issues were also involved, and stayed on strike.

EXCHANGE MADE EASY.—Aircraft Exchange, Inc., will begin business on January 6 in New York and London to provide a centralized aircraft market information service. The company will also sell or lease used or new airline equipment.

ANOTHER FOR PAN AM.—A fourth Boeing 707-121 was delivered to Pan American World Airways on November 21 and a fifth was expected before this issue appears.

COMET DAMAGED. — The de Havilland Comet 3B, prototype of the B.E.A. version, was slightly damaged on December 1 when it struck a tree on the edge of the airfield while landing. The incident is under investigation but was not, we understand, caused by any malfunctioning of airframe or engines.

MORE NEWS ITEMS ON P. 873

Air Transport

Optimum Britannia Operations

ON a recent occasion, two Britannias took off from New York for London separated by an interval of eight minutes. Following the same flight paths, they were flown in accordance with the operating techniques of the two different operators concerned. The aircraft which took off last was on the apron at London Airport by the time the other one landed.

This example—by no means an isolated one—was quoted by Mr. J. E. D. Williams in the course of a paper on "The Operation of the Britannia 300" given before the Bristol Branch of the R.Ae.S. on December 4. Mr. Williams, who was very closely concerned with the introduction into service of the Britannia with El Al, is now a consultant to C.P.A., Cubana, Aeronaves and El Al, principally on their Britannia operations. He has probably done more than anyone else to understand and develop the full potential of the long-range Britannia—as the success of El Al's Atlantic operations shows—and his paper last week was by way of being a classic survey of the theories which influence economic operation, and the practical application of these theories.

At the start of his paper, Mr. Williams explained that much of it tended to take the form of "this is the theory, but in fact we do it more simply." However obvious this appeared to be, it was the uniquely correct approach: first, to examine the theory applicable to a precisely defined aircraft navigating freely in a precisely defined atmosphere; and then to examine the effect of practical restrictions such as A.T.C. and of uncertainty of performance and winds. In this way, a broad band of approximately optimum operation is defined within which the simplest procedure must be selected. The airline operator must not sacrifice simplicity in a theoretical pursuit of economy or he loses both. Procedures which are complicated or unrealistic as seen from the flight deck will simply not be applied successfully.

Over a given route and in the hands of a given operator, the cost of operation and the saleability of seats for a given aircraft are controlled mainly through scheduling; payload-planning; flight-planning and fuel reserve; navigation and cruise control; and maintenance planning, facility and method. With the exception of maintenance, these were the topics discussed by Mr. Williams. We hope to summarize those parts of the paper dealing with the mathematical theories of cruise economics and payload-planning in a later issue.

So far as the Britannia 300 (including the 305 and 310) is concerned, cruise-control procedures are usually designed to meet one of three requirements: optimum economy, maximum range, or optimum range. The first of these is correct for ranges when neither fuel capacity nor weight is critical, and is the minimum-cost cruise weighted for the passenger attraction of speed. In practice the optimum economy cruise at any given altitude is at VNO or max c.r.p.m., whichever is limiting. In light winds, minimum-cost altitude is 0-2,000 ft. above the VNO altitude; with large tailwind shears, it is about 6,000 ft. above the VNO altitude and in strong headwind shears it is as near to VNO as possible.

These results are not typical for turboprops (and certainly not applicable to the Electra). If, for example, the VNO was much higher, or the cruise power a little lower, totally different procedures would have been applicable.

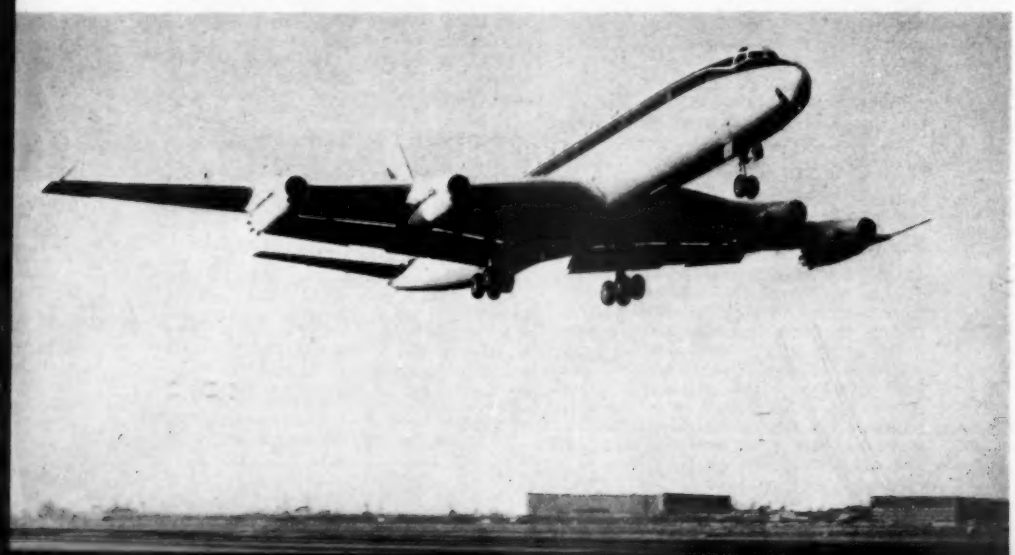
The maximum-range cruise technique is sometimes useful to conserve fuel when conditions deteriorate, or if headwinds, icing, etc., cause excessive fuel consumption en route. It is not usual, nor usually sound, to flight-plan for absolute maximum range with minimum reserves, but both C.P.A. and Aeronaves occasionally need to fly for maximum range in zero or tailwinds, and El Al in headwinds—where the problem is rather different.

The nearest approach to the ideal "drift up" for max. range permissible in most A.T.C. situations is the 2,000 ft. stepped climb. Each 2,000 ft. climb is made when a given I.A.S. is reached and, in zero or tailwinds, max. range is obtained as near as possible to the service ceiling. In the range of Britannia operating altitude, headwinds normally increase and true airspeed decreases with altitude, so it follows that max. range in a headwind is normally obtained at lower altitudes. Cases occur over the North Atlantic where flight 8,000 ft. below the level for max. specific range gives an improvement of 22% in range and 61% in ground speed.

The altitude for maximum range in a headwind depends, among other things, on the wind shear, which cannot be measured in practice. El Al have found it reasonable, however, to assume shear to be a function of headwind, thereby simplifying the flight-planning/navigation problem by eliminating one variable in the equation.

In the El Al technique, wind-component lines are superimposed on the flight-planning/howgozit chart to give direct presentation to the navigator of when to climb in terms of headwind, aircraft weight and ambient temperature. Thus, it is the navigator—whose skill in estimating and computing is involved—who determines the point at which to climb each step in a headwind, whereas the steps in zero or tailwind are based on I.A.S. presentation to the pilot—whose skill is involved, in this case, in flying the aircraft close to its service ceiling.

Optimum-range techniques are normally used on the North Atlantic, on Aeronaves northbound flights from Mexico City and on some C.P.A. routes. This is a modification of the max. range cruise and is one of the most difficult to reduce to a mathematical theory. The technique involves establishing an optimum flight profile, to be revised in flight as the uncertainty as to the future fuel requirement decreases. If all goes well, part of the fuel can be burned off on a faster profile; conversely, a longer-range profile must be adopted if conditions are adverse. The need to fly a stepped climb in practice usually simplifies



SECOND DC-8.—The first JT-4A (J-75)-powered Douglas DC-8 is seen here taking off from Long Beach for Edwards A.F.B. on November 29. This is the second DC-8; the first aircraft had on that date totalled 131 hours in 45 flights. The third and fourth aircraft are due to fly this month and will later be joined in the test programme by five more, including Rolls-Royce Conway-engined versions. The DC-8 seen here is for P.A.W.A. and the airframe had previously been used in the structural test programme.

flight-planning to a determination of the time at which to start one or two steps.

Just how simple the practical decisions can be was illustrated by the example mentioned at the beginning of this report. The details are worth quoting in full:—

In this case there was a strong tailwind shear between 65° W. and 30° W. on the minimum time path; the wind died away to the west of Ireland in a high-pressure ridge and in the last zones had a slight adverse component. The VNO altitude at commencement was 18,000 ft., ending up at about 23,000 ft.

Aircraft "A" took-off and selected 21,000 ft. For aircraft "B," 19,000 ft. would have been ideal to 65° W., where a step climb to 23,000 ft. would have become desirable because of the lower weight, lower air temperatures and strong tailwind shears. Aircraft "B," taking-off six minutes after "A," selected 23,000 ft. directly, knowing that if he cleared at 19,000 he would catch up on "A" up to 65° W. and would be trapped below him. During the 1½ hours required to reach the strong winds at 65° W., "A" lost a little time, having a slower airspeed at the lower altitude, but gained fuel with respect to "B."

When both aircraft entered the strong tailwind zone they had about the same ground speed due to wind shear, but "A" had the greater fuel flow. Doubtless he would wish to climb, but "B" was above him and overtaking, and a reclearance for "A" was out of the question. "B," having conserved fuel hitherto by flying at the higher altitude, was able to complete his flight over the light wind area near VNO altitude and watched "A" land from the apron at London Airport, "A" having finally reclearred to a higher altitude to obtain the endurance he desired after his earlier high fuel consumption.

In this case, and however sophisticated optimum profile planning may appear in theory, the only important decision for "B" was whether to accept 19,000 ft. or 23,000 ft. initially. Quick tactical decisions by the pilot are far more important than altitude selection at the flight-planning stage. They require of the pilot a sound knowledge of the effect of wind and wind-shear on the Britannia's economics; a knowledge derived from the flight plan of where the altitude spectrum lies at each stage of flight; a knowledge of the disposition of other traffic; and a little intelligence.

[And it is thanks to this approach to the subject, no doubt, that El Al's flight times over the North Atlantic average some 45 minutes less than those of B.O.A.C.'s Britannias, as Mr. Peter Masefield remarked when thanking Mr. Williams for his paper.]

Other points made by the speaker included the following:—

Optimum Flight Path. Without the use of optimum flight paths (in the horizontal plane) and the optimum flight profile (in the vertical plane) the Britannia would not be a non-stop Atlantic aeroplane with profitable loads, and would not compete, as it does, in full-payload westbound flights with the quasi-Atlantic jets in current operation.

Payload Planning. Among the problems of payload planning, for all operators working near the maximum range condition, is the increased risk of a technical stop through accepting last-minute freight. Duty dispatchers can be presented with a table which translates the general equation of the optimum flight profile and allows for varying commodity rates. The decision whether to carry or not is determined by a terminal reserve requirement variable with conditions in the destination area as well as route requirements. It is always more economical to go on a longer-range cruise than leave any commodity behind.

Variable Fuel Reserve. Use of the variable fuel reserve technique on the North Atlantic by El Al has led to a negligible number of unscheduled landings for refuelling compared with the occasions on which it has made possible high payload, non-stop operation without at any point in any flight developing a potentially unsafe situation. Further refinement of variable fuel reserve procedures requires development and improvement of fuel measurement systems.

Versus the Jet. Maintaining an average payload of 65% on Britannias may require a 100% load in some seasons and segments—which usually means more load could have been sold. In these conditions an operator who could hope to average only 65% on a jet the same size as a Britannia, might find a jet with 25% additional capacity and 10% higher direct operating costs a good buy.

There are a number of airlines in the World (some with flourishing short-range operations on which the long-haul jet is useless) where long-range operation is specialized, low-frequency and often on only one route. For such operators there is no sign of an aircraft which can compare with the Britannia 310, provided only that there is no jet competition for the traffic.

Discussing Take-off Monitors

THE desirability of providing the pilot of turbojet aircraft with some positive means of assessing take-off performance has long been obvious. The problems have been discussed officially on several occasions—notably at the International Civil Aviation Organization's Airworthiness Committee meeting last July—and have been referred to many times in the pages of THE AEROPLANE.

Last week, armed with ICAO working papers and with brochures and leaflets from various instrument and other manufacturers, representatives of the International Federation of Air Line Pilots' Associations sat down in London in a well-conducted attempt to clarify the requirements and to agree, if possible, on the best optimum means of presenting the information.

For the benefit of those who have not been concerned with the matter, it might be explained that, though the assessment of performance during take-off has always been mildly difficult for a pilot, it has become more critical with the appearance of the turbojet transport. Not only does the turbojet's longer ground run and (generally) higher take-off speed leave little room for error—and very little time indeed for decision—in marginal conditions, but the more even (and initially poorer) acceleration and low noise level of the turbojet make judgment of comparative take-off performance especially difficult. Furthermore, not only must the unstick speed be selected and applied with greater accuracy in the case of a turbojet transport, but the pilot has, in the course of his normal flying duties, to assess relative accelerations over a much wider variation of aircraft weights and effective thrusts than when handling piston-engined or turboprop-powered aircraft.

Since the need became accepted—and the more obvious "external" aids, such as runway marker-boards, were agreed to be both clumsy and insufficiently practical for day-to-day use—a number of manufacturers have come forward with equipment or with proposals for suitable instrumentation. The majority of the present proposals have concerned ingenious means whereby the necessary information—such as acceleration, ground-speed, runway-distance-covered and distance remaining—could be supplied, co-ordinated and presented in relation to a pre-calculated performance estimate, but two, at least, make use of the Doppler radar principle.

The pilots' name for such a device, in whatever form it may be offered as production equipment, has, for the past year or more, been the "go/no-go" indicator. As a term this is effective and succinct, but it does not fully describe what is needed. The pilot does not simply want to be told at decision speed—with clanging bells and flashing lights—that the take-off must be abandoned; he wants to know the worst long before his giant has eaten up most of the runway and is pounding along towards the opposite threshold at 100-odd knots. The term "take-off monitor" seems to describe the requirement more accurately and, if a more robust expression is needed, what is the matter with our old friend "howgozit"?

Whatever the final variants of such a monitor may be, the essentials are that it should be reliable and "fail-safe" and that the indications should be unequivocal. Otherwise we shall have saddled the airlines with the expense and disruption of an excessive number of abandoned take-offs and even of an equally excessive number of still more expensive cases of "buying the farm"—to use an American test pilot's expressive term for going off the end of the runway.

Among the many interesting, and sometimes not normally considered, points brought out in the preliminary discussions was one to the effect that the risks involved in an abandoned take-off were now tending to be much greater than those involved in the continuation of a take-off when the performance was (or appeared to be) sub-standard. The statistics concerned were necessarily based on military experience, for which smaller margins were acceptable, but the findings are obviously applicable to the turbojet transport. This leads naturally to the view that an acceptable monitoring device must give early warning of sub-standard performance. Nevertheless, if the warning is not to be a spurious one it must be given at a late moment during the initial run.

One of the less considered points in favour of a monitoring device is its long-term value as a means of assessing average aircraft and pilot performance during take-off. For such purposes—and for military use—a ground-based monitor might be the best solution, but it was generally agreed that, for civil use, the equipment should be airborne. Apart from pilot preferences, it is obvious that it might be many years before relatively expensive ground-based equipment could be made available at civil airports—and it probably never would be available at smaller or diversion fields where, in fact, the need for a monitor might be greatest.

Other points concerned the effects on take-off of bumps on the runway, of puddles or slush hit when the aircraft is nearing decision speed, of gradients and of different types of surfaces where runways have been extended or worked upon. It was suggested that, with the use of average passenger weights and the fact that some airlines did not always weigh carry-on luggage, take-off weights were inaccurate and might even be dangerously so, though the total payload of a turbojet transport

is only a relatively small proportion of the gross weight.

The dangers of the use of wind information obtained early from a tower which might be a mile or more from the runway were also mentioned. One of the difficulties seems to be that, with so many doubtful variables, the original sum may be optimistic and the monitor-measured performance may, in difficult conditions, be outside the tolerance unless this is large.

To the onlooker the general opinion of the meeting seemed to be that the chosen monitor should provide continuous and easily translated take-off progress information, should be fail-safe, be easily set up from flight manual information, be independent of any other system and have a 2%, or better, level of accuracy.

It seemed, too, that information about the amount of runway remaining at any moment of the take-off would be more than valuable, since this would tell the pilot whether, after abandoning the take-off, normal or emergency braking was required. One could hazard the suggestion that, when using a monitor in regular service, the first decision point might be moved well back from V1; so, for the big jets there might be four critical points—VD (first decision), V1 (final decision), VR (rotation speed—i.e., lift nosewheel) and V2 (unstick).

Six different devices were discussed at the IFALPA meeting; five of them were airborne and two, including a proposal for ground-based equipment, used Doppler principles. In the order in which they were presented to the meeting these were from Minneapolis-Honeywell, Marconi (airborne Doppler), Avien, Nortronics (ground-based Doppler), Servomechanisms and Sperry. The following summaries outline their features.

1. Minneapolis-Honeywell. This combines the information provided by an accelerometer and an odometer, or rolling-distance recorder. The linear accelerometer (its readings modified by the odometer to give an equivalent acceleration reading) provides the "go/no-go" signal prior to passing the refusal point; the odometer information is used primarily to estimate the amount of runway remaining, so that the necessary braking effort can be gauged, as well as providing supplementary progress information during the roll. The predicted values of acceleration and of distance to refusal point, set in as datums, are obtained from special charts.

2. Marconi. The provisional plans for the Marconi monitor are for the use of X-band cw transmission with one or two fixed (probably, but not necessarily, backward-facing) aerials and a tracking system deriving acceleration, speed and distance gone. Initial flying trials (starting this month) will be based primarily on the monitoring and checking of velocity information. The acceleration sensor will be independent. A proposed presentation consists of a dial with a semi-circular scale from which can be read ground-speed, predicted ground-speed and distance to the decision point; two windows give, respectively, the setting index and the warning information. Investigations have been in progress for six months. An accuracy of 1-2% is predicted.

3. Avien. The monitors proposed by Avien, Inc. (Woodside, New York), consist of: (a) A simple odometer system, giving take-off distance gone. (b) A ground-speed/distance comparison system with distance counter and "go/no-go" indicator. (c) A ground-speed/distance comparison system and "go/no-go" indicator backed up by "effective thrust" (or acceleration) indications, primarily derived from the pilot system, which can be compared with a pre-calculated datum. The ground-speed and distance-gone information is supplied by a wheel-revolution sensor. The pilot's indicator could consist of lights (green for "go" and flashing red for "no-go"), a counter giving the distance gone and an "effective thrust" meter with appropriate green and red segments.

4. Nortronics (Division of Northrop Aircraft). This is a ground-based system using Doppler for measuring the take-off roll acceleration and speed. This information is compared with that predicted by a computer into which is fed the aircraft weight, thrust and wind-speed, temperature and pressure (the last three at the runway and immediately prior to take-off) and which calculates the expected ground roll.

The basic information (weight and aircraft type and computed take-off distance) is shown on a board beside the runway. Lights along the runway edge show, by their colour, whether or not the take-off is progressing according to plan—green for normal and red if the acceleration drops below a pre-determined value while the stopping distance is still available. Once the safe-stopping (or "no-sweat") area has been passed the lights do not go red unless a successful take-off is shown by the computer to be absolutely impossible.

5. Servomechanisms. Because it is restricted, no information was given about the measuring and computing part of the system proposed by Servomechanisms, Inc. The display was, however, described. This is of the vertical tape type giving the continuously computed point of take-off (compared with that estimated) and the length of runway remaining after a fully braked stop. The existing runway condition can be set in so that the computer can estimate the stopping distance likely to be required.

6. Sperry (New York). An acceleration response is used by Sperry as the basis for their monitoring system. The recorded acceleration is compared with a datum, taking into account thrust, gross weight and runway conditions. The device does not involve merely the direct readings from an accelerometer and integrator system since the readings would then show a continuous decrease of acceleration during take-off.

Airspeed is fed into the system so that the instrument reading is an "equivalent" acceleration and this reading will either remain constant if all is well during the run, or show a fall-off in the case of any serious loss of predicted performance. The display shows a semi-circular scale of acceleration with performance index and suitable acceleration-fall-off markings around the scale. Counters on the instrument dial show the set-in take-off weight and the expected equivalent acceleration figure.—H.A.T.

Princess Project

MORE than usual interest attaches to the latest project for the use of the three Saro Princess flying boats stored at Cowes and Calshot. A new company (the name is not yet registered), of which A. V. M. Donald Bennett and Mr. B. G. Halpin (a Southampton businessman) are joint managing directors, has entered a bid to purchase, re-engine and operate the Princesses on routes across the South and North Atlantic. Associated with the project is G.Q. Aircraft Developments, Ltd. (a wholly-owned subsidiary of the G.Q. Parachute Co.).

The proposal is to fit the Princesses with six turboprops (they originally had 10 Proteus each). Suitable engines are the 4,445 e.h.p. Proteus 765, which would be immediately available and has been salt-water tested, or the 4,795 e.h.p. Tyne R.Ty.1, less far developed, but a little more economic. The group estimates that the Princess could carry about 200 passengers in a mixed-class layout, and have a range of 6,000 miles.

There are several difficulties confronting this enterprising proposal. In the first place, B.O.A.C. would have to agree to some form of competition from the new company. The fact that the U.S. Navy is studying the possibility of using the Princesses as atomic engine test beds also might make the M.o.S. postpone an early decision. Technically, a good deal remains to be done, and to complete certification trials would require, probably, about 1,000 hours' test flying. The company believes the first modified Princess could be flying by next autumn. Terminal facilities already exist at Southampton but the Marine Terminal there is quickly becoming derelict.

Memorial Discussion

ON December 9, the Council of the Air League of the British Empire met to discuss the R.34 Memorial that is to be erected at London Airport and which was debated in the House of Lords recently (THE AEROPLANE for November 28). Meantime, at the annual general meeting of the Guild of Air Pilots and Air Navigators on November 20, the following resolution was adopted:—

"The Freemen of the Guild of Air Pilots and Air Navigators assembled in General Meeting on November 20, 1958 while applauding the initiative of the Air League of the British Empire in proposing to commemorate the double crossing of the Atlantic by H.M. Airship R.34 in 1919 by a memorial to be erected at London Airport, place on record their view that the form of the memorial, as reported in the Press, is not appropriate to perpetuate the memory of a great aeronautical achievement and the men who contributed to its accomplishment, and request the Court to communicate this view to the Air League, to the Minister of Transport and Civil Aviation, and to others who may be concerned."

The Court of the Guild hopes that other aeronautical organizations will consider taking appropriate action.

Hunting-Clan's Loss

ON December 2 one of Hunting-Clan Air Transport's Viscount 700s crashed near Camberley on a post-overhaul test flight with the loss of the six members of the flight and engineering crew including the company's chief pilot, Capt. R. W. L. Mulliner. The aircraft, G-ANRR, a Type V.732, had left L.A.P. at 13.18 hrs. and was airborne for about 12 minutes.

Although explanation and detailed information must await the findings of the accident investigation team there seems to be no doubt that the Viscount was in trouble as soon as it had left the ground. The necessarily brief and sporadic RT messages from the captain will have been recorded at L.A.P. and/or heard by crews of other aircraft listening-out on the same frequency, so there will be guiding evidence to explain at least some of the symptoms of the control difficulties experienced.

Capt. R. W. L. Mulliner, D.F.C., joined Hunting Air Travel in November, 1946. He became a flight captain in October, 1952, and was appointed chief pilot on January 1, 1954. In 1955 he received the Queen's Commendation for Valuable Service in the Air.

European Traffic Trends

CONSOLIDATED statistics for the intra-European traffic carried by member airlines of the Air Research Bureau in the second quarter of 1958 are tabulated below. Figures for the previous quarter appeared in THE AEROPLANE for August 29.

The statistics show that European traffic increased by 8% in the period April-June, 1958, compared with the same quarter of 1957; the increase for the first quarter of 1958 was 11% and for the last quarter of 1957, 13%. As the capacity offered increased by 20%, passenger load factor declined from 62.1% to 55.9%. The 13% increase in freight traffic compared with 2% and 7% increases in the two previous quarters.

	2nd quarter		1958 as % of 1957	12 mths. ending		1958 as % of 1957
	1957	1958		June 1957	June 1958	
Seat/km. (million) ..	1,693	2,035	120	5,789	7,065	122
Pass./km. (million) ..	1,052	1,139	108	3,494	3,965	114
Pass. load/factor % ..	62.1	55.9	—	60.4	56.1	—
Freight tonne/km. (million)	11.5	13.1	113	45.9	50.6	110
Mail tonne/km. (million)	3.2	3.3	102	12.6	13.7	109

Intra-European traffic includes all traffic on international routes which originate and terminate within the European continent and countries bordering the Mediterranean. Airlines included in this survey are Aer Lingus, Air France, Alitalia-L.A.I., B.E.A., Finnair, Iberia, Icelandair, K.L.M., Lufthansa; S.A.S., Sabena and Swissair.

U.S. domestic traffic in the same quarter was much more adversely affected by the business recession than that in Europe. While capacity increased by 9%, passenger traffic actually showed a decline of 0.1%, compared with the same period of 1957. Passenger load factor went down from 63.94% to 58.54%.

The leading place of the Vickers Viscount in Europe is shown by the fact that 34% of all passengers flew on Viscounts in the second quarter. Next was the Convair 340/440, responsible for 22%, followed by the DC-6B, 12%. Average number of seats offered per flight increased from 48 to 51.

The Benina Accident Report

MISINTERPRETATION of the altimeter reading by the pilot is recorded as the most probable cause of the accident to a Central African Airways Viscount near Benina Aerodrome, Libya, on August 9. The report of the accident investigation has been published by the Libyan Ministry of Communications, price 5s. It was conducted by a board comprising Mr. J. C. Reynolds and Mr. M. Maddens, respectively chief operations officer and chief inspector of aircraft in the Federation of Rhodesia and Nyasaland Department of Civil Aviation; and Mr. J. K. Sutcliffe, Controller of Civil Aviation in Cyrenaica, representing Libya. The preliminary investigation in Libya was made by Capt. H. K. Gordon-Burge, an M.T.C.A. senior inspector of accidents.

The Viscount, VP-YNE, was operating the Zambesi service from Salisbury to London, and was completing the sector from Wadi Halfa to Benghazi (Benina Airport) when it crashed. Of the 54 persons on board, 32 passengers and four of the crew were killed.

The flight was operated entirely in accordance with prevailing regulations, and there was no evidence of any defects in the aircraft or its equipment. When 5½ miles from Benina, making a direct approach to Runway 33R on responder and locator beacons, the Viscount flew into high ground and caught fire. The controller in the tower saw the glow of this fire 20-30 seconds after the last message from the aircraft, in which the pilot announced that he was "leaving two-five now" (i.e., leaving 2,500 ft.).

At the point of impact, the Viscount should have been at about 1,650 ft. instead of 539 ft. (above aerodrome level). Examination of the wreckage showed the aircraft was laterally level and slightly nose down. Assuming it was actually at 2,500 ft. when the last call was made, the aircraft would have had to descend at between 3,100 and 4,600 ft./min. to reach the impact point; this rate of descent was ruled out by survivors' evidence and examination of the wreckage. Since DME was being used and was known to be in working order, the aircraft's position at the time of the last message was not in doubt.

The possibility that the altimeter millibar scale had been incorrectly set was rejected by the board of inquiry, as was the theory that the captain deliberately descended to 500 ft. above runway height in order to break cloud.

Misinterpretation of the altimeter reading by the pilot, therefore, seemed the most likely explanation. This theory was supported by the fact that the greater part of the descent had been made in clear weather and the pilot may not, therefore, have been concentrating as fully on his instruments as would have been the case in cloud. After entering cloud at about 2,000 ft., he would have been concentrating on the 100-ft. pointer and an over-reading error of 1,000 ft. made before entering cloud would then probably have been maintained. Such an over-reading made the rate of descent from the time of the last call acceptable.

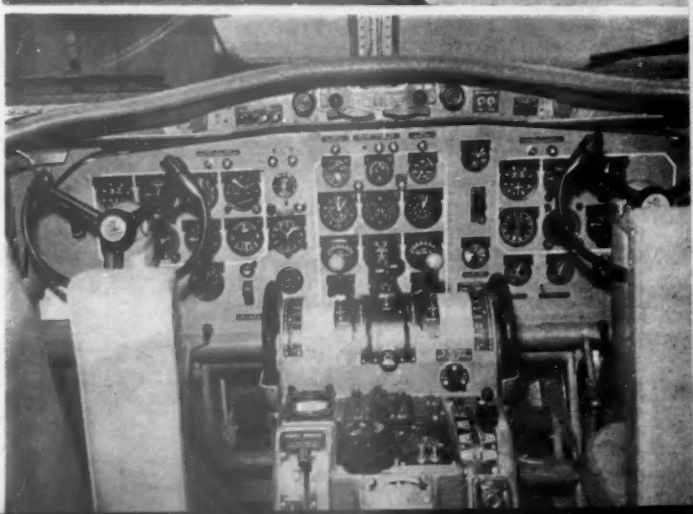
The board also noted that when the red cockpit lighting alone is in use, a shadow is cast over the top part of the altimeter dial. This is eliminated when the ultra-violet lighting is on; it is not known what lighting was in use at the time of the crash. Fatigue, and a slight indisposition, may have reduced the captain's efficiency. With his crew, he had been awake for over 19 hours, on duty for 12 hr. 44 min., and in the air for 9 hr. 40 min. since taking over the service at Entebbe: this in no way contravened the appropriate flight-time limitations.

The Prestwick Plans

FOLLOWING various proposals and counter-proposals (see THE AEROPLANE, October 17, p. 582) more detailed plans for the extension and development of Prestwick Airport were outlined in the House of Commons on November 20. The Minister of Transport had stated the facts briefly on an earlier occasion and these were reported in our issue of November 21, p. 771.

The Parliamentary Secretary to the Minister, Mr. Airey Neave, explained at some length that a start would be made next spring on an extension to the north-west of the already lengthened main runway from its present 7,500 ft. to about 9,800 ft. The runway extension would be ready for use by mid-1960. Work on plans for a new control tower and fire station at the intersection of the main and subsidiary runways was proceeding.

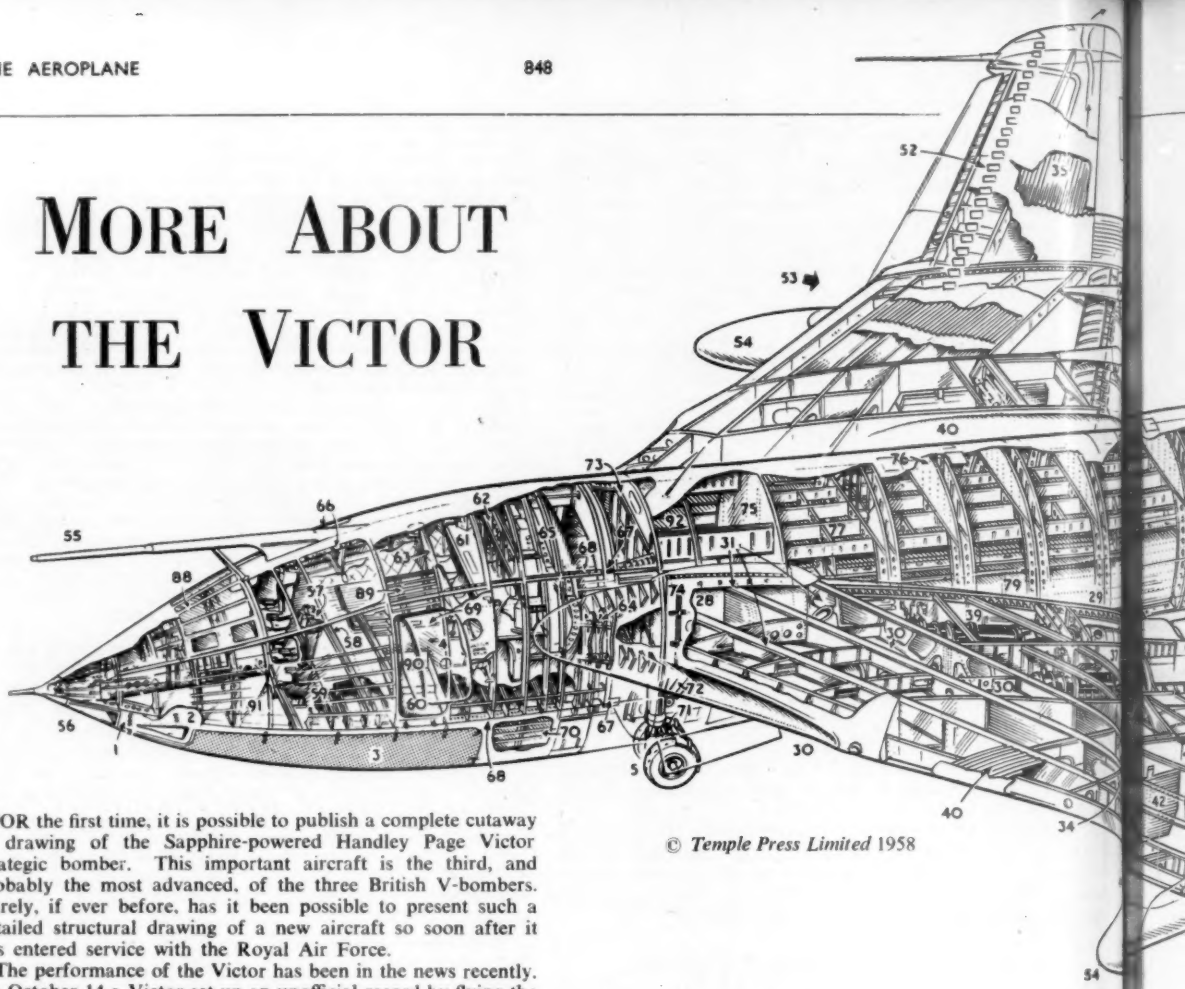
It had been decided that a tunnel for the A77 road under the runway extension would be too expensive and prospectively difficult if it were to be of adequate width. Such a project would, too, involve closing the runway for a long period. The road would therefore be diverted around the end of the runway—but work on a new by-pass road to the east of the airport, which would take about half the traffic, was now under way. A new terminal area would be constructed on a site at Redbrae beside the north-west extension of the runway.



Photographs copyright "The Aeroplane"

F-27 DEMONSTRATION.—On Thursday of last week Aer Lingus gave the first of eight series of demonstrations in England with their Fokker Friendships—at Manchester. On the right is a view of the control cabin with, above, a picture of the F-27 taxiing at Ringway.

MORE ABOUT THE VICTOR



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FOR the first time, it is possible to publish a complete cutaway drawing of the Sapphire-powered Handley Page Victor strategic bomber. This important aircraft is the third, and probably the most advanced, of the three British V-bombers. Rarely, if ever before, has it been possible to present such a detailed structural drawing of a new aircraft so soon after it has entered service with the Royal Air Force.

The performance of the Victor has been in the news recently. On October 14 a Victor set up an unofficial record by flying the 1,310 miles from Farnborough to R.A.F. Luqa, in Malta, at an average speed of 655 m.p.h. Six days later a Victor made a 2,480-mile Atlantic crossing between Goose Bay, Labrador, and Gaydon at a speed of 618 m.p.h.

Structural details of the Victor's wing were described in THE AEROPLANE of September 5. The information was derived from an article by Mr. R. H. Sandifer, assistant chief designer, structures, of Handley Page, Ltd. Further information on the Victor's fuselage structure, testing and undercarriage have now been given by Mr. Sandifer and the following description is based on his account.

Fuselage

The Victor's fuselage is built in three sections—front; combined centre and rear; and tail unit. The front fuselage consists of a pressurized crew cabin and a plenum chamber, pressurized by ram air, which holds important equipment. The centre and rear fuselage are constructed in one unit and form a torque box for balancing wing, tail and fuselage loads and includes the bomb bay and equipment compartment. The tail cone houses air brakes and braking parachute.

The crew cabin and most of the operational equipment are in the front fuselage, which is attached to the centre fuselage at four main pick-up points. The strength of these has been proved by static and fatigue tests. The two pilots sit side-by-side; the other three crew members face aft and sit just behind the entry door.

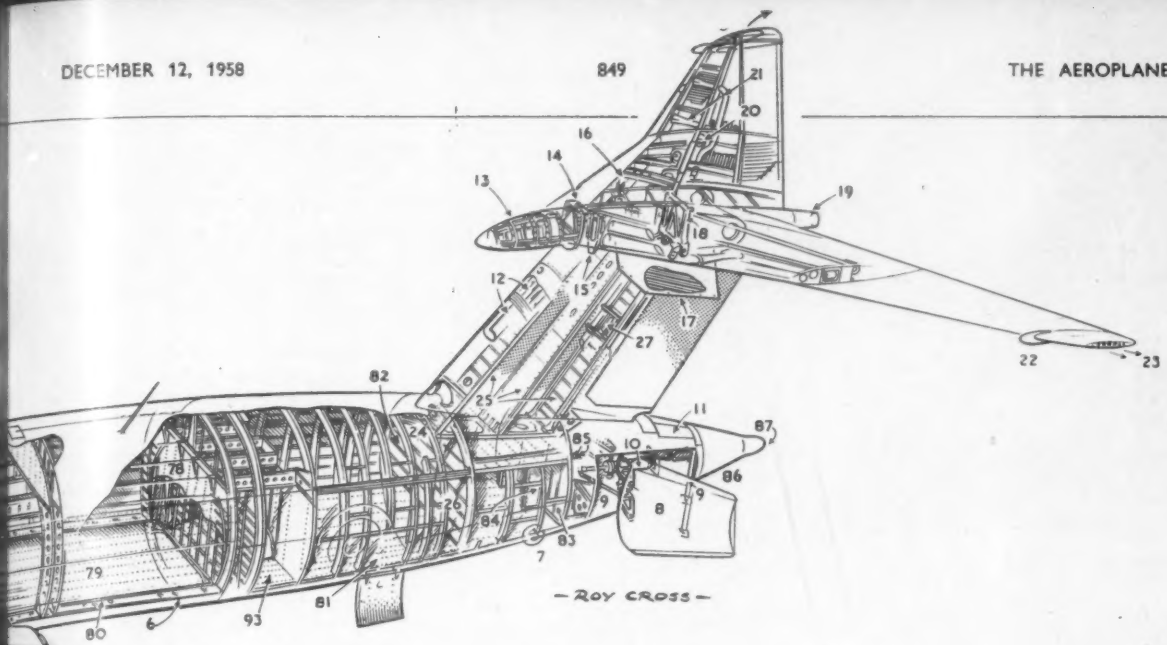
The pilots' windows are formed by long flat panels of strengthened glass with vinyl layers capable of holding the cabin pressure should the glass be fractured; de-misting is effected by a dry-air sandwich and warm-air jets. Similar panels are provided for the bomb aimer.

Pilot escape is by Martin-Baker ejection seats with power-operated escape hatches immediately above them. These hatches also have transparencies which allow upward vision. They are fully load-carrying.

The crew-entry door is on the port side. Opening upwards,

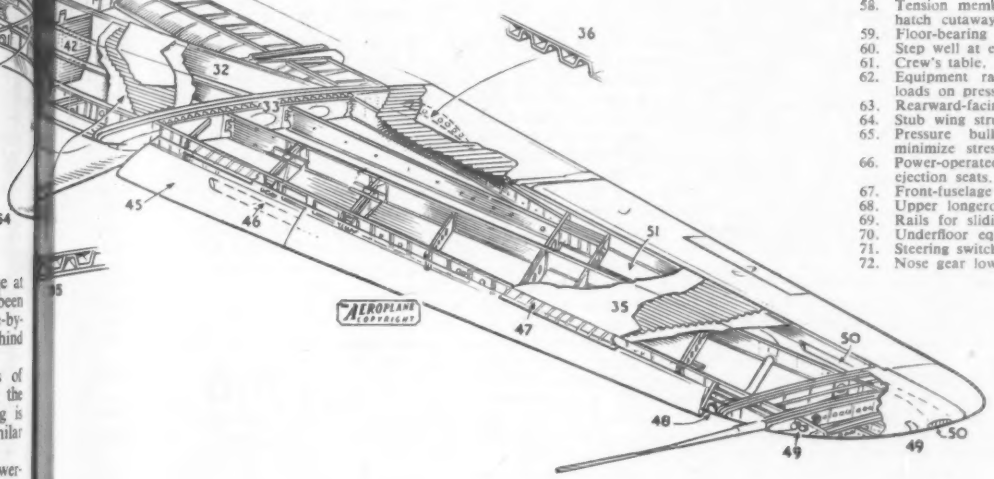
(*Continued on page* 850)

Victors of No. 10 Squadron, Bomber Command, at R.A.F. Cottesmore.



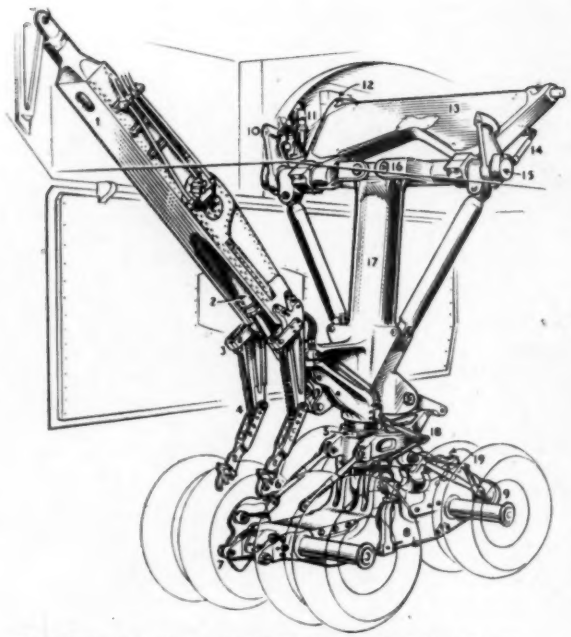
HANDLEY PAGE VICTOR B.1

Four 11,000-lb. s.t. A.S.Sa.7 Sapphires



KEY

1. Vortex generators.
2. Flush intake.
3. Detachable radome.
4. Crew entry door.
5. Rearward-retracting twin nose wheels.
6. Bomb-bay doors.
7. Tail bumper wheel.
8. Air-brake extended.
9. Air-brake hinge linkage.
10. Air-brake operating jack.
11. Tail-parachute stowage.
12. Anti-icing passages in leading edge for hot air.
13. Bullet fairing for T tail unit.
14. Slinging point.
15. Fin front-attachment fitting.
16. Elevator power-unit compartment.
17. Hinged access panel to elevator power unit.
18. Forging for fin rear-spar pickup.
19. Light tail-fairing structure.
20. Elevator hinge.
21. Hot-air anti-icing duct.
22. Mass balance.
23. Hot-air outlet (anti-icing).
24. Shear fitting at base of fin front-spar.
25. Fin front and aft main spars and secondary middle spar form two torsion boxes.
26. Reinforced structure to carry tail loads.
27. Rudder operation skew-lever mounting.
28. Main wing-fuselage joint.
29. Subsidiary wing-fuselage joint.
30. Main air intake divides to feed buried engines separately.
31. Three spars making two torsion boxes form inner-wing main structure.
32. Outboard of landing gear there are four main spars forming three torsion boxes which extend to the outer wing panel.
33. Inner-to-outer wing joint.
34. Major rib has corrugated-sandwich web.
35. Spanwise corrugated-sandwich skin on outer wing.
36. Chordwise-corrugated skin reinforcement over wing trailing-edge behind torsion boxes.
37. Fire-resistant engine-bay bulkheads have webs of high-grade commercially pure titanium.
38. Landing-gear support beam.
39. Armstrong Siddeley Sapphire A.S.Sa.7 engines each of 11,000-lb. thrust.
40. Top skin reinforced with chordwise-corrugated sheet in vicinity of power units and landing gear, and on parts of leading edge.
41. Eight-wheel main landing-gear bogie.
42. Main landing-gear door.
43. Flap-track housings.
44. Flaps extended.
45. Two-piece leading-edge flap.
46. Hot-air anti-icing in nose flap.
47. Nose-flap shroud.
48. Cooling air inlet-duct.
49. Wing-tip lights.
50. Cooling-air exit-duct.
51. Aileron power-unit compartment.
52. Vortex generators along upper wing surface.
53. Bag fuel tanks within wing structure.
54. Under-wing fuel tank.
55. Air-to-air refuelling probe.
56. Bomb aimer's window.
57. Pilots' ejection seats.
58. Tension members strengthen structure around hatch cutaway.
59. Floor-bearing beams.
60. Step well at entrance door.
61. Crew's table.
62. Equipment racks are built in, help spread loads on pressure bulkhead.
63. Rearward-facing seats for three crew members.
64. Stub wing structure.
65. Pressure bulkhead (basically spherical to minimize stresses).
66. Power-operated escape hatches for pilots' ejection seats.
67. Front-fuselage pick-up-points.
68. Upper longeron.
69. Rails for sliding crew seats.
70. Underfloor equipment compartment.
71. Steering switch on nose wheel.
72. Nose gear lower radius rod.
73. Ram-air-pressurized equipment bay (plenum chamber).
74. Centre section rib.
75. Bomb-bay front bulkhead (in line with rear spar).
76. Box-section frame.
77. Four girders are main stiffening for bomb-bay roof, from which are suspended bombs or other military loads.
78. Bomb-bay rear bulkhead.
79. Bomb-bay is long and unobstructed.
80. Heavy lower longeron in vicinity of bomb-bay.
81. Equipment bay and access door.
82. Bulkhead distributes tail loads.
83. Rear bulkhead terminates main fuselage section.
84. Box structure distributes tail loads.
85. Fuselage tail section pick-up points.
86. Tail cone.
87. Tail radome.
88. Pilots' windows of strengthened glass with vinyl layers. Demisting by dry-air sandwich and warm-air jets.
89. Entrance door flanked by specially strong frames and structure to carry pressure and shear loads.
90. Entrance door doubles as emergency exit. "Blinkers" on door act as air shield when crew members bail out.
91. Crew compartment floor is of metal-faced ply, laid wood face upwards to give non-slip surface.
92. Primary box of the inner wing structure passes through fuselage here.
93. Thicker skin locally to counter jet efflux effects.



VICTOR MAIN LANDING GEAR (Starboard unit):—
1. Radius rod; 2. Retraction jack; 3. Hook stops; 4. Spring box and folding arm; 5. Bogie stop pad; 6. Safety selector switches; 7. Bogie rollers; 8. Bogie; 9. Auxiliary shock absorber (dashpot); 10. Down-lock hook; 11. Down-lock jack; 12. Retraction link bearing; 13. Retraction link; 14. Retraction link spring units; 15. Bearing block; 16. Yoke; 17. Main shock absorber; 18. Brake piping; 19. Reaction pads.

(*Continued from page* 848)

it has load-carrying hinges at the top and latches at the bottom. This door is also the emergency exit for aircrew; protective shields on the door prevent crew members from being affected by the airflow during their initial escape.

The underfloor structure of the nose fuselage carries much operational equipment and is not pressurized. The forward part is a large one-piece sandwich radome made of glass-cloth laminates with a foamed-rubber filling.

Unlike the remainder of the primary structure, the crew cabin is constructed entirely of aluminium-copper alloy sheets. This is because skin stresses have been kept low in the interests of fatigue and, therefore, do not warrant the use of the highest-strength light alloy available.

The large bomb bay, completely unobstructed, forms most of the rear fuselage. Its roof is supported by four equally spaced fore-and-aft girders running the full length with light but strong floor skins between them. The fore-and-aft girders are attached at suitable intervals to heavy box-section frames; these are the main supports for bombs or other military loads.

The bomb bay has two long doors whose double-skin construction gives high torsional stiffness. They are actuated by hydraulic jacks at each end and retract inside the bomb bay. Behind this bay there is a small equipment compartment and the box structure which carries the tail unit. The extreme rear of the fuselage is a detachable tail in which are two large clam-type air brakes, operated hydraulically, and the housing for the braking parachute.

The primary box of the inner wing passes through the centre fuselage at right angles to the fore-and-aft axis. At the fuselage side the three main centre spars are kinked through approximately 45°. The central box is of standard wing construction and holds flexible bag fuel-tanks. These are separated transversely by a central fore-and-aft bulkhead of sandwich construction and also by the central main spar.

The main shell of the rear and centre fuselage is of conventional skin-stringer construction supported by bulkheads and heavy frames. In between these are light frames which stabilize the stringers against torsional and flexural instability. These stringers are of "hat" section and are spot-welded to the skin. Frames are generally attached only to the stringer flanges: but shear plates to provide frame-to-skin attachment are fitted where loads are high.

In some regions the upper shell has an inner skin with closely spaced stringers, a form of sandwich not needing a continuous corrugated core as used on the wing because of the circular shape of the fuselage cross-section. The main bending strength of the fuselage is completed by a substantial longeron of extruded high-strength light alloy which runs along the upper edge of the bomb-bay opening in lieu of stringers.

Jet-efflux effects have been catered for by the use of thicker skins locally on the lower fuselage side, just aft of the bomb bay.

Materials used in the fuselage primary and secondary structure, apart from the pressure cabin, are the same high-strength light alloys used for the wings. Strategic joints in the top shell structure have been tested for fatigue endurance and fail-safe characteristics.

Undercarriage

The Victor's undercarriage has been designed and produced by Electro-Hydraulics, Ltd., in close collaboration with Handley Page. Each main unit carries four double wheels whose comparatively small diameter facilitates their housing in the inner wing just outboard of the engines. The runway load from each leg is spread over eight wheels mounted on a balanced bogie. This bogie is pivoted at the bottom of a vertical oleo-pneumatic shock-absorber leg with adequate sideways and drag bracing. A secondary dashpot connects the leg to the rear of the bogie. Retraction is by hydraulic power.

High-grade steels and high-strength light alloys are used and the undercarriage has an outstanding strength/weight ratio. It caters completely for all landing conditions and severe ground manœuvring, including turning about one leg. Strength tests have fully confirmed the design requirements. The twin-wheel nose undercarriage has wheels mounted independently on a single oleo-pneumatic shock-absorber leg, castoring through a total angle of 175°.

Steering is by two hydraulic jacks at the top of the leg, operating through a total angle of 90°.

Structural Tests

A full range of structural tests was made on both prototype and production Victors. A combined tip-to-tip wing with the centre and rear fuselage structure attached, was subjected to a series of major tests representing the most critical landing case and towing conditions, the most severe symmetric flight loading, the maximum asymmetric manœuvre and the maximum negative acceleration case.

Major structural tests were made in a large steel girder frame with movable overhead cross gantries and a specially reinforced concrete floor. Its overall dimensions are 130 ft. long by 30 ft. high by 45 ft. wide. Most test cases were taken to between 85% and 90% of design ultimate conditions and a final case chosen for which the test loading was increased to produce ultimate failure.

These tests have led to improvements to the structure which were incorporated at suitable stages either to ensure satisfactory compliance with design requirements or to add still further to the aircraft's operational capabilities.

A smaller test frame was built so that the complete tail unit and its attachment to the rear fuselage could be tested simultaneously. At least four major design cases were represented consecutively, with numerous stiffness tests specially undertaken for aeroelastic investigations.

The cabin was tested separately, not only for static loads but also to prove its fatigue characteristics. These tests involved the application of cyclic pressure loadings and, in the interests of safety and preservation of the specimen, were made with the cabin completely submerged in a water tank.

Full-scale fatigue tests on the crew cabin and the plenum chamber revealed a number of secondary weaknesses which have been remedied. They also proved that the pressurized compartments had adequate life and the structure was of a fail-safe character.

H.P. Retirements

TWO Handley Page executives who have been closely associated with the Victor retired from the company recently. They are Mr. W. H. MacRostie, chief engineer, and Mr. H. Smith, works manager.

Mr. MacRostie, who was born in 1893, joined Handley Page, Ltd., in 1919 and remained with the company until his retirement, apart from a short break of about a year in the early 1930s. He had been a charge-hand, foreman, works superintendent, aerodrome superintendent at Radlett, experimental manager, and chief engineer. As chief engineer he was responsible for the flight-test programme and engineering development of the Victor.

Mr. Smith, born in 1889, had been with Handley Page since 1915, apart from a gap between 1920 and 1924. He joined the company as a fitter and had in turn been foreman, works superintendent and works manager.

Britain's VTOL Industry

ALTHOUGH, as the title of this article suggests, there is in Great Britain an industry which offers a wide selection of aircraft having vertical take-off and landing capability, its efforts to date have been almost entirely confined to the rotary-wing types. For this reason the bulk of this particular survey will be related to British helicopter developments. It would not be fair, however, to suggest that the direct jet lift technique has been ignored in this country as a promising solution to the VTOL requirement. Indeed, a considerable amount of pioneering work has been done in this direction, and has led to the current programme of research with the Short S.C.1 flat riser.

There are many ways in which these various degrees of VTOL capability can be accomplished and in America there are as many projects currently being flown. In this country our limited research and development resources have not permitted such a generous approach, and we have concentrated on the development of the direct jet-lift technique. This has sprung from the pioneering experiments by Rolls-Royce with their vertical thrust-measuring rig which "flew" for the first time in August, 1953, and the subsequent development of the Rolls-Royce R.B.108 direct-lift engine especially for VTOL.

While at present the Short Brothers and Harland team is the only one officially known to be concerned with British VTOL development in this category, it is common knowledge that the Hawker design team has been working on such a project for some time. Just what sort of craft this is has not been revealed, but it would be a fair assumption that it is most likely to be a high-performance fighter with direct-lift thrust for vertical take-off and landing. It has long been known that there is a NATO requirement for such an aircraft. One might assume, too, that other British aircraft companies are at least investigating the possibilities; and, likewise, the provision of special powerplants is not likely to be confined to one particular section of our aero-engine industry. In this context, the name of Bristols has been mentioned; their project, we believe, favours the use of a single powerful engine to provide both lift and thrust.

However, be that as it may, Britain's VTOL interests are currently represented by the S.C.1, which was seen in public for the first time at the S.B.A.C. display. This particular aircraft was the first of two prototypes, and although it had been flown in the aeroplane configuration the proper vertical-thrust engines were not installed and it was not demonstrated in the air.

A pure research craft, the S.C.1 has a delta wing for normal forward flight sustentation and a bank of four 2,010-lb. s.t. R.B.108s in the centre section for vertical lift. A fifth R.B.108 provides the necessary forward thrust for the normal flight régime. An account of the S.C.1 specially written for us by the company's chief test pilot, appears on page 855.

So far as civil versions of the other-than-rotary-wing VTOL craft are concerned, these have yet to be projected. At present the interest lies primarily in research with a trend towards Service applications. But British civil aviation has already shown its awareness of the potentialities of the new aircraft form, and British European Airways has drawn up a provisional specification for an airliner with VTOL capability. This specification (THE AEROPLANE for January 24, 1958) is intended to indicate the sort of requirements an airline might ask to be fulfilled should it plan to make use of such an aircraft.

In the rotary-wing field development has already been made from the pure helicopter toward the compound type with fixed wing surfaces providing a sizeable proportion of the lift during forward flight. This technique, claimed by its protagonists as the logical development of the helicopter, has been applied to the Fairey Rotodyne, whose wings at cruising speed provide some 60% of the total lift while the autorotating main rotor supplies the remainder. In the Rotodyne, forward thrust is provided by two normal airscrews driven by Napier Eland shaft-turbine engines; and for the vertical-flight régime the main rotor is driven as a helicopter by tip jet units.

A potential 48-seater, the Rotodyne can claim to be the World's first VTOL airliner. The prototype, seen in public at the S.B.A.C. display this year, has completed more than 55 hours of flying to date, including no less than 80 transitions from helicopter to autorotational flight.

Great interest has been shown in the Rotodyne by airline operators in many parts of the World and by the American armed forces. Because of this, the company has entered into an agreement with the Kaman Aircraft Corporation in America whereby that organization will be responsible for the sale and manufacture of the Rotodyne in the U.S.A. An order for one aircraft has already been received from the Okanagan Helicopter Group of Canada with an option for an unspecified further number.

Fairey's Rotodyne — the World's first VTOL airliner.

It is, however, a matter for concern that to date there has not been more active official support for this important project. Although its initial development was backed by a Ministry of Supply contract, subsequent Government economies brought this support to an end, and since December 31 of last year the Fairey company have been financing the project themselves—to the tune of well over half a million pounds.

Fairey's other helicopter, the little Ultra-Light two-seater powered by a Blackburn-Turboméca Palouste supplying compressed air to the tip jet units, has also continued as a private venture following the termination of an M.o.S. contract. The company has two of these helicopters flying and, during the past year, they have given convincing demonstrations of their usefulness. Recently, an Ultra-Light was sent to Canada for demonstration to the Canadian armed forces.

As protagonists of the pure helicopter, Westland Aircraft Ltd. have, in the large VTOL aircraft category, concentrated on a development of the well-tried Sikorsky S-56, for which they have a manufacturing licence. This aircraft, the Westminster, is the largest conventional helicopter built in Europe, and although originally designed as a civil transport carrying up to 44 passengers it has been built initially in a crane-transporter version with an open-framework fuselage capable of lifting six tons.

The Westminster is powered by two Napier Eland shaft-turbine engines which are mounted side-by-side on top of the fuselage. This arrangement makes for a compact rotor-plus-powerplant unit giving considerable freedom in the choice of fuselage configuration to "hang" underneath.

Two prototypes of this "utility" version have been laid down by the company on a private-venture basis. The first of these has now been flying since June and has completed more than 30 hours in the air to date.

The second prototype is in a fairly advanced stage of construction and is scheduled to fly in the spring of next year. It will differ from the first machine in a number of respects—primarily in refinements to turn it into production form.

For example, it will have two 250-gallon external fuel tanks mounted on the fuselage sides in place of the internal tanks of the prototype. The undercarriage has been redesigned by Dunlops and will be lighter to the extent of some 500 lb. The rotor pylon mounting structure has also been refined and has resulted in a useful weight saving. And a simple air-transfer system for the fuel system has been adopted in place of the present electrical booster-pump arrangement with an emergency air system.

There has been a World-wide interest in the Westminster in its crane-transporter form, and the first application of it might well be in the military rôle. It can, of course, be adapted as a utility army transport with some form of glass-fibre fairings to protect the passengers. For the more sophisticated applications as a civil passenger or mixed-freight carrier the final form of the fuselage has yet to be decided. The various requirements of potential customers are being closely studied, and it may well be that to cater for these duties a version with a podded fuselage would appear attractive: certainly a rear-loading layout would seem to be desirable. (See p. 869.)

Apart from their development work with the Westminster, Westland's main activities are concerned at present with the production of their Gazelle-powered Wessex helicopters for the

Royal Navy. These will be used for anti-submarine duties, and for this purpose are being equipped with the latest form of automatic control system—which, it is claimed, will enable the Wessex to be flown in all weathers by night and day.

The first production-type Wessex (the prototype, which flew in the 1957 S.B.A.C. Display, was based on an American-built airframe) made its initial flight in June of this year. This was the first of a development batch ordered by the Ministry of Supply and its maiden flight was made within two years of the signing of the contract.

Whirlwind 7s powered by Alvis Leonides Major engines are also in production at Yeovil for the Royal Navy, and during the past year an order for Whirlwinds was placed by the Austrian Government. Two Whirlwinds—to be known as the Mk. 8—have been ordered for the Queen's Flight and are to be delivered in the New Year. To date about a dozen Widgeons have been built and another two dozen or so are on order. More than 400 helicopters have so far been built by Westlands.

The Westland team are giving no indications of their current thinking in relation to new helicopters, but it would be safe to assume that even though they are concentrating on the Westminster and its possible derivatives, they are also giving some attention to other possibilities. One would not be surprised, for example, if the Westminster type of layout with two engines on top of the fuselage were to be applied to a Wessex with two of the small new turbine engines.

To Bristol's helicopter division at Weston-super-Mare has gone the distinction of producing Britain's first turbine-powered twin-rotor helicopter—the Type 192 with two Napier Gazelles. Although this craft is a direct descendant of the Type 173, which made its début in 1952, it is, in fact, a new design.

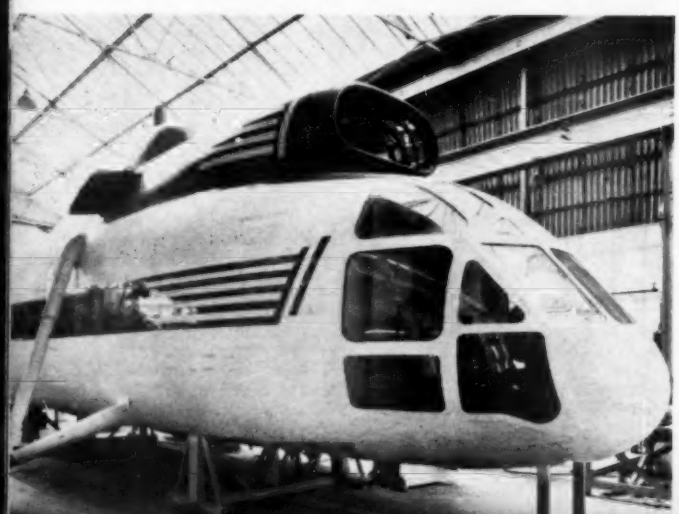
In its initial application it will be used in a military rôle, but the Type 192 also has possibilities as a civil transport. The major task at Weston at present, then, lies in the production of these Type 192s for the R.A.F. This is now well under way and a production line is firmly established. The first Type 192 made its maiden flight in July of this year and the second is scheduled to fly before the year is out.

The other main activity at Weston is the continued production of Sycamores for the German Air Force. Production of Sycamores is now, however, being tapered off, and at present the plans are that no more will be built after the spring of next year. When this programme comes to an end no fewer than 180 Sycamores will have been built.

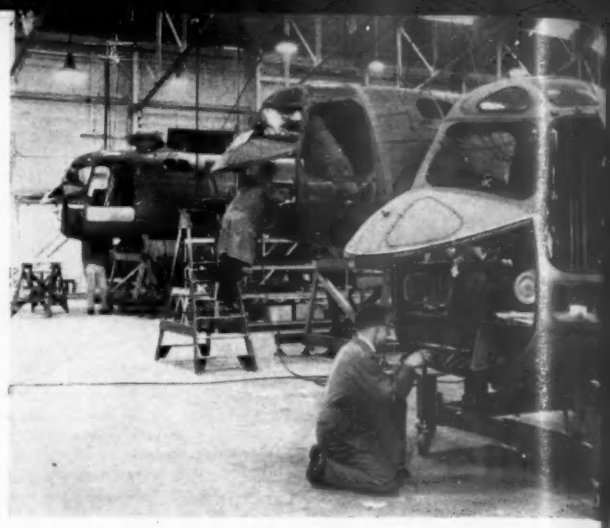
For the larger sizes of rotary-wing craft the Bristol team have always favoured the tandem rotor layout; similarly, they have long been firm believers in the use of fixed wing surfaces to unload the rotor during forward flight. Although no information is forthcoming about the trend of their thoughts in relation to an eventual successor to the Type 192, no doubt, if and when it materializes, it will represent some logical extension of their existing experience. (A sketch of a Bristol project with a single wing mid-way between the rotors was published in THE AEROPLANE for December 14, 1956.)

Similarly, one would expect any Sycamore successor from the Bristol team—and there have been unconfirmed reports of such a project—to be a straightforward extrapolation from the current design. Turbine power would certainly be chosen and presumably would be either a de Havilland Gnome, an Armstrong Siddeley P.181 or Blackburn-Turboméca A.129. With these powerplants one would expect a rather larger helicopter than the 171 with, perhaps, accommodation for as many as six or seven passengers.

As the principal producers of small helicopters in this country Saunders-Roe are currently devoting most of their effort to production of the two-seater Skeeter powered by a de Havilland



The mock-up of Westland's civil-transport Westminster project.



Part of the assembly line of Bristol 192s for the R.A.F.

Gipsy Major and to the preliminary flight-test programme of their new P.531 turbine-powered five-seater. So far as the Skeeter is concerned, the order for 10 of these little helicopters for the West German armed forces is very nearly completed; the last of these machines is scheduled for delivery early next year. The quantity of Skeeters involved in the order for the British Army has not been revealed, but it has been said to be substantial.

Making its début at the S.B.A.C. Display this year the Saro P.531 attracted a great deal of interest, and no doubt has since been the subject of inquiries from the Services and other potential operators. Although use is made of Skeeter components, this is a new design in which the prime requisite has been a small, compact helicopter capable of World-wide operation and accommodating five people. The Blackburn-Turboméca Turmo was selected as the initial powerplant, although it has been planned from the outset that the ultimate P.531 would have a powerplant in the 800-1,000-h.p. category. In point of fact it was decided that production-type airframe and transmission should be capable of taking this higher power.

The first prototype P.531 flew on July 20 of this year, less than seven months after the decision to build the machine as a private venture had been taken. The second prototype flew on September 30. To date the first P.531 has completed just over 65 hours of flying and the second about 25 hr.

Saro's latest venture in the small-helicopter business lies in their agreement recently signed with Helicop-Air of Paris, who are the European agents for the Hiller Aircraft Corporation. This covers the manufacture in Britain by the Saunders-Roe company of the little Hiller XROE-1 Rotorcycle. A single-seater powered by a Nelson two-stroke, the Rotorcycle weighs 556 lb. all up. As there is relatively little constructional work involved in the Rotorcycle, it should be possible for Saro to have one flying within six months—with the rotor blades and engine supplied from the U.S.

From all the foregoing it will have been apparent that none of the developments described could have come about without the help and backing of the aero-engine industry. Indeed, the introduction of gas-turbine power to rotary-wing craft has been one of the major post-war developments and we, in this country, can take special pride in being in the forefront of this development.

In the piston-engine field, Alvis continue to be the principal suppliers of the more powerful units with their 520-b.h.p. Leonides radial in the Sycamore and Widgeon, and their 715-b.h.p. Leonides Major twin-row radial in the later versions of the Whirlwind and in the Bristol 173 Mk. 3. In the smaller category of piston engines specially adapted for the helicopter, there is a 215-b.h.p. de Havilland Gipsy Major four-cylinder in-line powerplant used in the Skeeter.

In the turbine-engined field Napiers at present can claim the major share. Their 1,450-s.h.p. Gazelle powers the Wessex, and in a 1,650-s.h.p. version the Bristol 192; and their Elands are in the Rotodyne (rated at present at 3,000 e.h.p.) and the Westminster (rated at present at 2,400 s.h.p.).

For those applications which need the lower powers the Blackburn-Turboméca range is available. The Palouste, for example, powers the Fairey Ultra-Light and the 400-s.h.p. Turmo the Saro P.531.

For the future, this range of British turbine powerplants for helicopters will be enlarged with the introduction of the de Havilland Gnome, the Armstrong Siddeley P.181 and the Blackburn-Turboméca A.129. Of these, the first two are in the 1,000-h.p. category, while the third is designed to deliver 840 s.h.p. for take-off.—F.T.M.

Britain's VTOL Aircraft . . . .

BRISTOL 171

FIRST helicopter of British design to enter production, the Bristol 171 is available in both civil and military versions. The total of 170 delivered to date includes 44 of an order for 50 from the Federal German armed forces, and two of these are furnished to special V.I.P. standards. Normal accommodation is for four/five persons, or pilot, medical orderly and two stretchers in the ambulance role. Up to 1,600 lb. of freight can be carried externally under the fuselage. Power plant is a 500/520 b.h.p. Alvis Leonides 524/1 piston-engine.

Dimensions.—Rotor dia., 48 ft. 7 in.; length (blades folded), 46 ft. 2 in.; height, 12 ft. 2 in.; disc area, 1,856 sq. ft.

Weights.—Normal take-off, 5,600 lb.; empty, 3,965 lb.; disc loading, 2.9 lb./sq. ft.

Performance.—Cruising speed, 91–107 m.p.h. at 2,000 ft.; inclined climb, 1,200 ft./min.; service ceiling, 14,500 ft.; normal range, 268 miles.

BRISTOL 192

DEVELOPED from the earlier tandem-rotor Bristol Type 173, the Type 192 has been ordered to meet R.A.F. requirements for a helicopter capable of troop and freight transport, para-trooping, supply dropping, casualty evacuation and search-and-rescue duties. It is powered by two 1,650 s.h.p. Napier Gazelle N.Ga.2 free-turbine engines, has equipment for night instrument flying, and accommodates 18–25 fully armed troops or 6,000 lb. of freight, or 12 stretcher cases, three sitting casualties and a medical orderly. A 5,250-lb. load can be carried externally. The first Bristol Type 192 flew on July 5, 1958.

Dimensions.—Rotor dia., each 48 ft. 8 in.; length, 89 ft. 9½ in.; height, 17 ft.; disc area, each 1,860 sq. ft.

Weights.—Normal take-off, 18,000 lb.; empty (operational), 10,481 lb.; disc loading, 4.84 lb./sq. ft.

Performance.—Cruising speed, 138 m.p.h. at sea level; inclined climb, 1,180 ft./min.; service ceiling, 13,250 ft.; normal range, 432 miles with 2,600 lb. payload.

FAIREY ULTRA-LIGHT

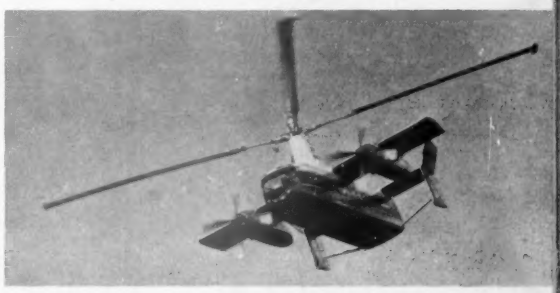
INTENDED originally for army observation and liaison duties, this extremely agile little two-seater is now offered for a wide range of civil and military applications. It is transportable on a standard 3-ton truck, which it can use as a mobile "airfield," and has been operated successfully from a 9-ft. square platform on a naval frigate in rough sea conditions. The Ultra-Light's two-blade main rotor is driven by tip-mounted pressure-jets, supplied with air by a 252 e.h.p. Blackburn-Turboméca Palouste 500 air-bleed engine.

Dimensions.—Rotor dia., 28 ft. 3½ in.; fuselage length, 14 ft. 8 in.; height, 8 ft. 2 in.; disc area, 630 sq. ft.

Weights.—Normal take-off, 1,800 lb.; empty, 950 lb.; disc loading, 2.86 lb./sq. ft.

Performance.—Cruising speed, 86 m.p.h.; inclined climb, 1,350 ft./min.; hovering ceiling with ground effect, 10,000 ft.; range, 185 miles, or 100 miles with 220 lb. payload.

FAIREY ROTODYNE



DESCRIBED as the World's first VTOL airliner, the Rotodyne is designed to take off and land vertically as a helicopter, and to cruise like a fixed-wing aircraft, with its rotor auto-rotating and the two 3,500 e.h.p. (3,000 e.h.p. in prototype) Napier Eland N.El.7 turboprops driving conventional propellers. In vertical and hovering flight, the Elands drive auxiliary compressors to supply air to the pressure jets mounted at the tips of the four-blade rotor. Suitable for military or civil use, the Rotodyne will carry 48 passengers or 15,000 lb. of freight, including vehicles, in its production form.

Dimensions.—Rotor dia., 90 ft.; length of fuselage, 58 ft. 8 in.; span of wings, 46 ft. 6 in.; height, 22 ft. 2 in.; disc area, 6,360 sq. ft.

Weights.—Normal take-off, 39,000 lb.; empty, 24,000 lb.; disc loading, 6.13 lb./sq. ft.

Performance.—Cruising speed, 184 m.p.h.; inclined climb, 2,400 ft./min.; hovering ceiling, 7,000 ft.; range, 345 miles with 10,000 lb. payload and reserves.

SAUNDERS-ROE SKEETER

CHOSEN for service with the R.A.F., British Army and the Army and Navy of Federal Germany, the Skeeter is being delivered in A.O.P., flying training and liaison versions. In its Series 7 form it is powered by a 215-b.h.p. de Havilland Gipsy Major 215 piston engine, which can be supplemented by a Napier rotor-tip hydrogen peroxide rocket system. With the rockets in use, it has a max. forward speed of 115 m.p.h. at sea level and vertical rate of climb of 1,400 ft./min. Normal seating is for two side by side, but a stretcher can be carried externally on each side of the cabin.

Dimensions.—Rotor dia., 32 ft.; length of fuselage, 26 ft. 8 in.; height, 7 ft. 6 in.; disc area, 804 sq. ft.

Weights.—Normal take-off, 2,200 lb.; empty, 1,656 lb.; disc loading, 2.86 lb./sq. ft.

Performance.—Cruising speed, 101 m.p.h.; inclined climb, 1,150 ft./min.; service ceiling, 12,800 ft.; range, 213 miles.

SAUNDERS-ROE P.531

DESIGNED, built and flown in prototype form in six months, as a private venture, the P.531 is a general-purpose helicopter using many rotor and transmission system components of the Skeeter. Its 425 s.h.p. (derated to 300 s.h.p. in prototypes only) Blackburn-Turboméca Turmo 600 free-turbine engine drives a four-blade main rotor and can be run on low-octane gasoline, kerosene or light diesel oils. Normal accommodation is for two persons in front, with a rear bench-type seat for three. The rear seat will fold flat against the bulkhead to make room for two stretchers or freight.

Dimensions.—Rotor dia., 32 ft. 6 in.; fuselage length, 29 ft.; height, 9 ft. 6 in.; disc area, 827 sq. ft.

Weights.—Normal take-off, 3,800 lb.; empty, 2,092 lb.; disc loading, 4.6 lb./sq. ft.

Performance.—Cruising speed, 115 m.p.h.; inclined climb, 1,600 ft./min.; service ceiling, 18,000 ft.; max. range, 322 miles.

Royal Navy. These will be used for anti-submarine duties, and for this purpose are being equipped with the latest form of automatic control system—which, it is claimed, will enable the Wessex to be flown in all weathers by night and day.

The first production-type Wessex (the prototype, which flew in the 1957 S.B.A.C. Display, was based on an American-built airframe) made its initial flight in June of this year. This was the first of a development batch ordered by the Ministry of Supply and its maiden flight was made within two years of the signing of the contract.

Whirlwind 7s powered by Alvis Leonides Major engines are also in production at Yeovil for the Royal Navy, and during the past year an order for Whirlwinds was placed by the Austrian Government. Two Whirlwinds—to be known as the Mk. 8—have been ordered for the Queen's Flight and are to be delivered in the New Year. To date about a dozen Widgeons have been built and another two dozen or so are on order. More than 400 helicopters have so far been built by Westlands.

The Westland team are giving no indications of their current thinking in relation to new helicopters, but it would be safe to assume that even though they are concentrating on the Westminster and its possible derivatives, they are also giving some attention to other possibilities. One would not be surprised, for example, if the Westminster type of layout with two engines on top of the fuselage were to be applied to a Wessex with two of the small new turbine engines.

To Bristol's helicopter division at Weston-super-Mare has gone the distinction of producing Britain's first turbine-powered twin-rotor helicopter—the Type 192 with two Napier Gazelles. Although this craft is a direct descendant of the Type 173, which made its début in 1952, it is, in fact, a new design.

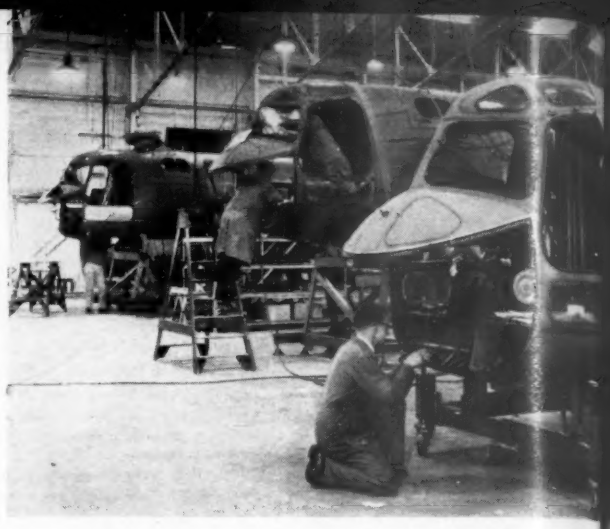
In its initial application it will be used in a military rôle, but the Type 192 also has possibilities as a civil transport. The major task at Weston at present, then, lies in the production of these Type 192s for the R.A.F. This is now well under way and a production line is firmly established. The first Type 192 made its maiden flight in July of this year and the second is scheduled to fly before the year is out.

The other main activity at Weston is the continued production of Sycamores for the German Air Force. Production of Sycamores is now, however, being tapered off, and at present the plans are that no more will be built after the spring of next year. When this programme comes to an end no fewer than 180 Sycamores will have been built.

For the larger sizes of rotary-wing craft the Bristol team have always favoured the tandem rotor layout; similarly, they have long been firm believers in the use of fixed wing surfaces to unload the rotor during forward flight. Although no information is forthcoming about the trend of their thoughts in relation to an eventual successor to the Type 192, no doubt, if and when it materializes, it will represent some logical extension of their existing experience. (A sketch of a Bristol project with a single wing mid-way between the rotors was published in THE AEROPLANE for December 14, 1956.)

Similarly, one would expect any Sycamore successor from the Bristol team—and there have been unconfirmed reports of such a project—to be a straightforward extrapolation from the current design. Turbine power would certainly be chosen and presumably would be either a de Havilland Gnome, an Armstrong Siddeley P.181 or Blackburn-Turboméca A.129. With these powerplants one would expect a rather larger helicopter than the 171 with, perhaps, accommodation for as many as six or seven passengers.

As the principal producers of small helicopters in this country Saunders-Roe are currently devoting most of their effort to production of the two-seater Skeeter powered by a de Havilland Gipsy Major and to the preliminary flight-test programme of their new P.531 turbine-powered five-seater. So far as the Skeeter is concerned, the order for 10 of these little helicopters for the West German armed forces is very nearly completed; the last of these machines is scheduled for delivery early next year. The quantity of Skeeters involved in the order for the British Army has not been revealed, but it has been said to be substantial.



Part of the assembly line of Bristol 192s for the R.A.F.

Making its début at the S.B.A.C. Display this year the Saro P.531 attracted a great deal of interest, and no doubt has since been the subject of inquiries from the Services and other potential operators. Although use is made of Skeeter components, this is a new design in which the prime requisite has been a small, compact helicopter capable of World-wide operation and accommodating five people. The Blackburn-Turboméca Turmo was selected as the initial powerplant, although it has been planned from the outset that the ultimate P.531 would have a powerplant in the 800-1,000-h.p. category. In point of fact it was decided that production-type airframe and transmission should be capable of taking this higher power.

The first prototype P.531 flew on July 20 of this year, less than seven months after the decision to build the machine as a private venture had been taken. The second prototype flew on September 30. To date the first P.531 has completed just over 65 hours of flying and the second about 25 hr.

Saro's latest venture in the small-helicopter business lies in their agreement recently signed with Helicop-Air of Paris, who are the European agents for the Hiller Aircraft Corporation. This covers the manufacture in Britain by the Saunders-Roe company of the little Hiller XROE-1 Rotorcycle. A single-seater powered by a Nelson two-stroke, the Rotorcycle weighs 556 lb. all up. As there is relatively little constructional work involved in the Rotorcycle, it should be possible for Saro to have one flying within six months—with the rotor blades and engine supplied from the U.S.

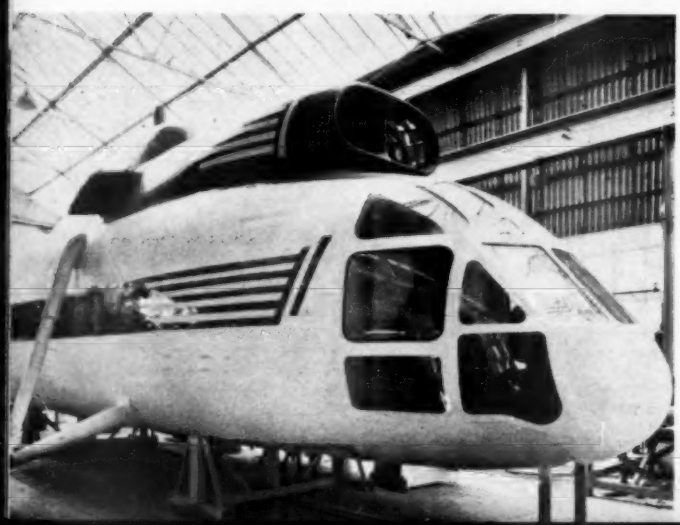
From all the foregoing it will have been apparent that none of the developments described could have come about without the help and backing of the aero-engine industry. Indeed, the introduction of gas-turbine power to rotary-wing craft has been one of the major post-war developments and we, in this country, can take special pride in being in the forefront of this development.

In the piston-engine field, Alvis continue to be the principal suppliers of the more powerful units with their 520-b.h.p. Leonides radial in the Sycamore and Widgeon, and their 715-b.h.p. Leonides Major twin-row radial in the later versions of the Whirlwind and in the Bristol 173 Mk. 3. In the smaller category of piston engines specially adapted for the helicopter, there is a 215-b.h.p. de Havilland Gipsy Major four-cylinder in-line powerplant used in the Skeeter.

In the turbine-engined field Napiers at present can claim the major share. Their 1,450-s.h.p. Gazelle powers the Wessex, and in a 1,650-s.h.p. version the Bristol 192; and their Elands are in the Rotodyne (rated at present at 3,000 e.h.p.) and the Westminster (rated at present at 2,400 s.h.p.).

For those applications which need the lower powers the Blackburn-Turboméca range is available. The Palouste, for example, powers the Fairey Ultra-Light and the 400-s.h.p. Turmo the Saro P.531.

For the future, this range of British turbine powerplants for helicopters will be enlarged with the introduction of the de Havilland Gnome, the Armstrong Siddeley P.181 and the Blackburn-Turboméca A.129. Of these, the first two are in the 1,000-h.p. category, while the third is designed to deliver 840 s.h.p. for take-off.—F.T.M.



The mock-up of Westland's civil-transport Westminster project.

Britain's VTOL Aircraft . . . .

BRISTOL 171

FIRST helicopter of British design to enter production, the Bristol 171 is available in both civil and military versions. The total of 170 delivered to date includes 44 of an order for 50 from the Federal German armed forces, and two of these are furnished to special V.I.P. standards. Normal accommodation is for four/five persons, or pilot, medical orderly and two stretchers in the ambulance role. Up to 1,600 lb. of freight can be carried externally under the fuselage. Power plant is a 500/520 b.h.p. Alvis Leonides 524/1 piston-engine.

Dimensions.—Rotor dia., 48 ft. 7 in.; length (blades folded), 46 ft. 2 in.; height, 12 ft. 2 in.; disc area, 1,856 sq. ft.

Weights.—Normal take-off, 5,600 lb.; empty, 3,965 lb.; disc loading, 2.9 lb./sq. ft.

Performance.—Cruising speed, 91–107 m.p.h. at 2,000 ft.; inclined climb, 1,200 ft./min.; service ceiling, 14,500 ft.; normal range, 268 miles.

BRISTOL 192

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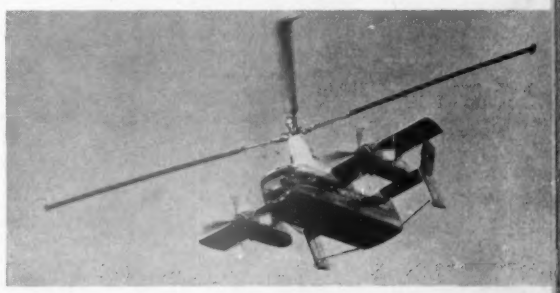

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Performance.—Cruising speed, 115 m.p.h.; inclined climb, 1,600 ft./min.; service ceiling, 18,000 ft.; max. range, 322 miles.

Britain's VTOL Aircraft . . . .

WESTLAND WHIRLWIND

SEVERAL HUNDRED Whirlwinds have been produced by Westland for civil and military duties. The initial versions, of which many are in service with the R.A.F. and Royal Navy, were basically straightforward licence-built Sikorsky S–55s, with 600-b.h.p. Pratt & Whitney R–1340 or 700-b.h.p. Wright R–1300 engine; but the latest Whirlwind HAS.7 has a 715-b.h.p. Alvis Leonides Major 755/4. Built specifically for anti-submarine duties, it carries sonar detection equipment and a homing torpedo. A transport version for 10–12 passengers, six stretchers or equivalent freight is available.

Dimensions.—Rotor dia., 53 ft.; length of fuselage, 41 ft. 8½ in.; height, 15 ft. 7½ in.; disc area, 2,210 sq. ft.

Weights.—Normal take-off, 7,800 lb.; empty (operational), 5,375 lb.; disc loading, 3.53 lb./sq. ft.

Performance.—Cruising speed, 99 m.p.h.; inclined climb, 1,200 ft./min.; absolute ceiling, 13,200 ft.; range, 334 miles at 86 m.p.h.

WESTLAND WIDGEON

THE Widgeon is an S–51 Dragonfly with a completely new cabin, which enables a fifth person to be carried in comfort. It is in production at Yeovil, and existing Dragonflies can be converted easily into Widgeons, as changes involve mainly replacement of the forward part of the fuselage and the rotor head, which is of the Whirlwind type with metal rotor blades. An alternative cabin arrangement enables two stretchers to be carried, with a medical attendant. The engine is a 515-b.h.p. Alvis Leonides 521/2.

Dimensions.—Rotor dia., 49 ft. 2 in.; fuselage length, 40 ft. 10 in.; height, 13 ft. 2¼ in.; disc area, 1,900 sq. ft.

Weights.—Normal take-off, 5,900 lb.; empty, 4,322 lb.; disc loading, 3.1 lb./sq. ft.

Performance.—Cruising speed, 88 m.p.h.; inclined climb, 1,190 ft./min.; service ceiling, 10,500 ft.; range, 310 miles.

WESTLAND WESSEX

BASED on the Sikorsky S–58, the Wessex brings all the advantages of turbine power to a well-proven airframe. Production is centred at present on an anti-submarine version for the Royal Navy, powered by a 1,450-s.h.p. Napier Gazelle N.Ga.13 free-turbine engine and carrying the latest search equipment and strike weapons. Later, military and civil versions will be available for search and rescue, transport, casualty evacuation and training duties. These aircraft will carry 12 passengers and baggage, eight stretchers or 4,000 lb. of freight and will offer considerably better performance than the piston-engined S–58.

Dimensions.—Rotor dia., 56 ft.; overall length, 65 ft. 9½ in.; height, 15 ft. 10 in.; disc area, 2,460 sq. ft.

Weights.—Normal take-off, 12,600 lb.; empty (operational), 8,350 lb.; disc loading, 5.13 lb./sq. ft.

Performance.—Cruising speed, 127 m.p.h.; inclined climb, 1,650 ft./min.; service ceiling, 17,000 ft.; range, 400–630 miles.

WESTLAND WESTMINSTER

INTENDED originally as a simple and inexpensive flight-test vehicle for the engine, rotor and transmission system of the Westminster, the version illustrated is now offered as an efficient and highly manœuvrable flying crane with a lifting capacity of some six tons. The developed transport version with two 3,150-s.h.p. Napier Eland shaft-turbines will carry up to 45 passengers in a roomy cabin. Potential military loads will include 31 stretcher cases, or four jeeps in an external sling. Data below apply to the prototype "crane" as flying at present with 2,400-s.h.p. Eland 229s.

Dimensions.—Rotor dia., 72 ft.; overall length, 89 ft. 3 in.; height, 22 ft.; disc area, 4,070 sq. ft.

Weights.—Normal take-off, 30,000 lb.; disc loading, 7.36 lb./sq. ft.

Performance.—Vertical climb, 700 ft./min.; inclined climb 1,475 ft./min.; service ceiling, 14,000 ft.; hovering ceiling, (free air) 4,500 ft.

Britain's "Flat-riser" . . . .

SHORT S.C.1

INHERITOR of the direct jet-lift concept pioneered by the Rolls-Royce "Flying Bedstead," the S.C.1 foreshadows the time when even large supersonic aircraft will be able to dispense with long runways. Four 2,010-lb.-s.t. Rolls-Royce R.B.108 turbojets mounted vertically in its fuselage thrust it off the ground at take-off, control being achieved in this phase by air nozzles at nose, wingtips and tail. A fifth R.B.108 provides thrust for cruising flight with the lifting engines switched off. The latter tilt to a limited degree to aid transition. Following tethered tests, free flight trials are now in progress.

Dimensions.—Span, 23 ft. 6 in.; length, 24 ft. 5 in.; height, 10 ft. 8 in.

Weight.—Normal take-off, approx. 8,000 lb.

Performance.—No details available.

The S.C.1 from the Pilot's Viewpoint

by Tom Brooke-Smith*

THE development of the S.C.1 has involved many interesting problems from the pilot's point of view. He has new things to do and new controls to operate—and previous experience on normal aircraft has not always immediately supplied the answers. One of the first things I had to do was to obtain rotary-wing experience, and this has been a help.

The cockpit layout of the aircraft is interesting if a little complicated by the several research features which have been added deliberately by our engineers. There is a conventional control-column for ailerons and elevators, able to operate both the normal surfaces and the stabilizing air-nozzles situated at each wing-tip and at nose and tail. The rudder-bar operates the rudder and the yawing action of the fore and aft nozzles.

On the left-hand side beside the seat is another lever equivalent to the collective-pitch lever on a helicopter, and operating the lift-powerplant throttles when raised. The rear propulsion engine throttle is operated by a normal throttle lever on the pilot's left-hand console. As we want to operate this engine throttle at the same time as the lift-powerplant throttle and do not want to keep changing from one lever to the other, a motorcycle-type twist-grip on the end of the lift throttle also operates the rear-engine throttle and is coupled to the conventional lever so that either can be used.

Above, the instrument panel for the Short S.C.1 is neatly laid out with the various sub-panels easily seen.

Right, the S.C.1 during one of its free-hovering flight trials at Belfast.

On the right-hand console are the switches and warning lamps of the autostabilizer system. In front is the normal panel together with engine instruments (compressor pressure and JPT) for the lifting engines; eventually we will replace these with a "scanning" or semi-automatic system on a single dial.

As even test pilots have only two hands we could not arrange a lever to operate lift-powerplant tilt, with the lever indicating the tilt angle, so we move these engines by pressing a switch on the end of the control-column hand-grip, in the same way as a tailplane trimmer is operated. This means that I have to watch a position indicator, but eventually we will make this predetermined or automatic.

Hovering consists of raising the craft off the ground by lifting the left hand and monitoring the attitude or the plan of the aircraft by stick and rudder-bar movements. The lifting throttle on the aircraft is very good indeed and the accuracy of height control which the two other pilots and I have achieved has been very gratifying. To make small translational movements during hovering you incline the aircraft slightly so that "sine effect" moves you in the direction you lean. In practice this has proved surprisingly easy and the inclination necessary to move about is imperceptible.

So far, as I have mentioned, three pilots have hovered in the gantry, although I am the only one who has to date flown free outside it. We had each had Rolls-Royce "Bedstead" experience which has been most helpful, but judging by these results only two or three short hovers in the gantry are needed before you get the hang of the thing.

The undercarriage is interesting and very effective, if a little ungainly due to its length. A special design had to be devised to eliminate friction or springiness of the legs during extension at take-off. Obviously if the legs do not extend evenly the aircraft will lean over one way and tend to career off in that direction; this is aggravated by the all-swivelling wheels which we have used to deal with drift on landing. Incidentally, we have not had any evidence so far that this castoring feature is necessary but we have not made enough free landings yet to be sure on the point.

One of the first things we built at Belfast was a laboratory simulator, and this was followed by a dynamic rig. Working in the simulator I was able to get down to the studies of time lags, the business of stability, control effectiveness, response characteristics, damping, etc., with the engineers in our analytical department. These parameters were evaluated in conventional flight, in the hovering condition and across the transition speed band between hover and 1*g* stall. Stiffness terms and damping characteristics for the autostabilizer were selected in this way, and then re-checked on a "dynamic rig."

Described in the Press as a "skeleton" aircraft which will never leave the ground, the dynamic rig is an odd looking

* Chief test pilot, Short Bros. and Harland, Ltd.

framework representing in full scale the S.C.1 in mass and in dimension. The entire structure is supported by a spherical air bearing permitting the whole to move freely on a cushion of compressed air with little or no friction. The air supply is tapped from the compressor of an Avon gas turbine installed alongside.

On this rig we have carried out the functional testing of the elevator power control and the autostabilization and nozzle control systems. I have spent much time "flying" it, both for development and familiarization purposes. Hydraulic and electrical services, autostabilizer and transition mechanisms, as well as all instrumentation, are duplicates of those used in the actual aircraft.

The various terms or factors chosen as a result of tests on the electronic simulator and checked on the dynamic rig are those which we are using in free flight—so far they have proved to be just what seems necessary.

As already mentioned, the S.C.1 is controlled in conventional flight by elevators, ailerons and rudder. Ailerons and rudder are manually operated but the longitudinal control is power-operated with manual reversion. Power operation gives irreversibility without which, under certain conditions in vertical flight, the elevators could become unbalanced and impart movement to the stick which would then affect the pitch-nozzle controls. This does not occur in the case of the ailerons as the cross connections will tend to cancel out any disturbance due to vertical motion.

In conventional flight, feel is provided by a trimmable "q"-pot and, to cater for stationary and near stationary flight when this will be zero, a spring is incorporated. In manual control the stick forces are trimmed out by adjusting the elevator geared tab. As well as an elevator tab position indicator, a hinge moment "out of trim" indicator has been incorporated so that the aerodynamic forces may be zeroed before reverting to manual.

In jet-borne flight, control is provided by jet nozzles or "puff pipes" positioned under the nose and tail (pitch) and under each wing-tip (roll). The fore-and-aft nozzles are also connected to the pilot's rudder control and swivel differentially to provide yaw control. The nozzles are fed with air bled from the compressors of the four Rolls-Royce RB.108 lift engines.

Autostabilization is provided in pitch and roll, each axis having three independent stabilizer systems or channels, and a rotary switch enables the pilot to select either a "rate" or "fully stabilized" condition. A third position enables him to operate his controls using electric signalling—but without stabilization. And a further selector permits him to connect the autostabilizer to the control surfaces and/or nozzles or the pilot's column to both, or the pilot to the surfaces and the autostabilizer to the nozzles. This is definitely a research feature for experimental work only.

The occurrence of a fault in the stabilizer system is immediately signalled to the pilot by a piercing high-pitched squeal on his intercom. and a red warning light indicates the faulty channel. The three-channel system of stabilization supplies what we feel to be a very adequate safety margin.

I first flew the S.C.1 conventionally on April 2, 1957. Since then its design flight envelope has been cleared and it is a proven vehicle in this respect. All the same, the curtailment of the programme by the Ministry of Supply has not allowed me to build up the flying hours I would have liked.

Vertically, operations began in our gantry at Belfast earlier this year. Much extremely intensive engineering test work was carried out. In addition, from a flight point of view, I suddenly realized that I was professor and pupil—and both at the same time.

It was a most exhilarating business. I began by limiting operations to winds of less than 8 m.p.h. and always had a man with a hand anemometer stationed in front of me. Within a few days I was operating on normal test work in winds of 30 m.p.h. or so, as the aircraft is not sensitive to winds.

The autostabilizer system was subjected to very rough treatment and during some 100 gantry flights gave no trouble whatsoever. Finally, at the end of October, we brought the aeroplane out of its steel framework and flew it from a small platform in a corner at one end of a disused runway. It behaved beautifully. Since then there have been further free flights, during one of which I put it down on a football pitch to prove that, in an emergency, an aeroplane using this principle of jet lift can drop down almost anywhere.

The S.C.1 is a delightfully simple aeroplane to fly in vertical, hovering and near hovering flight. The crispness in response to throttle of its Rolls-Royce RB.108 engines present the pilot with an extraordinarily precise vertical control and this, together with its stability and very adequate control characteristics, make it extremely manageable in manœuvre. It is little affected by winds or gustiness and I have repeatedly demonstrated that it can be flown accurately and positioned to within limits of a foot or so even in gusts of over 40 m.p.h. such as were actually recorded on one occasion.

Having flown conventionally, having flown vertically, what now remains is to put these two phases together—to link them up in a transition. This part of the programme will start in a month or two.

Cruising speeds are now six times what they were in the early 'thirties and landing speeds, then about 60, are now something like 150 m.p.h. These speeds dictate miles of concrete. Using the orthodox configuration, it looks as though we have gone about as far as we can go. To progress to speeds of the order of M=2 and above, will require even longer runways. This won't do at all.

From a military standpoint too, we cannot put up with all this concrete: (A) we'd never have it in the right place to start off with and; (B) if we did it might be put out of action before we could use it. So we need a new way of getting aeroplanes airborne to allow us to dispense with all this costly and vulnerable concrete—in fact we need a new way to get aeroplanes into the air to enable really high-speed aircraft to operate at all.

The answer, I am sure, is the flat-rising VTOL aircraft. It feels the right way to do the job: it is the natural way to do it, and, to me, it is the obvious way to do it.

In the S.C.1 we are proving all the hardware—and finding out what is the best sort of hardware—necessary to get an aeroplane into and out of the air vertically whilst having the ability to fly as a normal aircraft in between times. Once proved, then this same hardware slightly tailored to individual requirements, of course, will enable any aeroplane to take-off vertically providing sufficient power is available.

I think, therefore, that we stand on the threshold of great things—militarily first, of course, and later on in the civil field. And I do believe that before long we shall be cruising across the World at speeds of the order of 2,000 m.p.h. Weather or fog will cause no hindrance or delay to airline schedules for these aircraft will be let down vertically under automatic control with the safety and smoothness that you would expect of a lift in a large department store.

VTOL is here now—to be used—and we must get in and use it and reap the reward. Much is at stake.

The chief test pilot "flying" the S.C.1 in the control simulator at Belfast.

VTOL Aircraft—the International Field

Three helicopters of the Royal Canadian Navy operating in the Arctic.

FROM the beginning, aeronautical engineering has been full of challenges and none has been more stimulating than that of providing an aircraft capable of ascending and descending vertically. The benefits accruing from this capability are so enormous that it is not surprising to find such a concentration of interest throughout the World, first on the rotary-wing aircraft and more recently on the other, so-called VTOL, types which have been made possible by the application of turbine powerplants.

These more advanced craft clearly open up tremendous operational possibilities and will certainly have a place on the aeronautical scene in the future. Equally, however, the helicopter *per se* will continue to serve as a form of aircraft having special characteristics that are particularly suitable for the accomplishment of many duties that demand a measure of vertical operation.

In point of fact, the helicopter is simply one form of VTOL aircraft—indeed, some aeronautical engineers in the rotary-wing business consider it to be the simplest and cheapest (and probably the quietest) of the VTOL craft. Certainly it represents the most efficient means of providing operational verticality when this constitutes a major part of the overall requirement and when hovering for lengthy periods in relation to the total flight time is called for.

Other forms of rotary-wing craft, such as those using fixed wings for providing lift in normal flight and the more extreme case of the tilting wing plus rotor-cum-airscrew arrangement, have come into being as a compromise for those applications in which the capability for extended hovering is of secondary importance. And the various forms of direct lift generation by means of a straightforward jet efflux offer the ultimate solution for bestowing VTOL capability on those aircraft for which the operational requirement demands little or no take-off or landing run with an otherwise "orthodox" aeroplane.

British helicopters and VTOL aircraft have already been surveyed on previous pages in order to complete our survey of Britain's current efforts in this particular direction. In the following 10 pages we have set out similar information and illustrations of the VTOL aircraft and helicopters of other countries.

All this material has been kept in the same form of presentation so as to facilitate comparison and thus provide the maximum of information. In each case there is an illustration; a descriptive note setting out the purpose and background of the type concerned; and some brief technical data giving the principal dimensions, weights and performance figures. In some cases the different forms in which manufacturers present their facts and figures have made it difficult to preserve a strict uniformity throughout the technical data section, but wherever possible we have standardized these data so that, in most cases, they are directly comparable.

In the survey that follows there are no fewer than 48 helicopters and 11 VTOL aircraft which, with the British ones on pages 853 and 854, make a total of 58 and 12 respectively from nine countries. For the purpose of the survey we have chosen to include only those machines which are in production at the present time or are undergoing active development. There are, of course, many other helicopters—and some VTOL aircraft—which are no longer being built as production craft or flown as experimental machines. And for obvious reasons we have not included the deflected-slipstream aircraft, which are more properly considered to be STOL rather than VTOL types.

The most noticeable—albeit expected—fact which emerges from a study of these pages of data is that the American helicopter contribution is such a high proportion of the total included. In point of fact, there are no fewer than 32 American helicopters, compared with 10 from the United Kingdom and six from the U.S.S.R.

Of the American rotary-wing craft, it is perhaps surprising to find so many single-seaters—nearly a third of the total—although it is not so surprising that this particular form of helicopter is at present confined to the United States. At the other extreme, so far as size is concerned, Russia can claim the biggest helicopter—while we in this country would appear to be ahead in the "airliner size" of helicopter having accommodation for 45-50 passengers.

By far the largest number of helicopters are still powered by piston engines. However, as a clear sign of the changing times, more than a dozen employ gas turbines to drive their rotor heads through shafting and gearboxes in the usual way—and there are about 10 for which tip-jet units of one sort or another are used to propel the rotor. In this connection it is interesting to find that while these gas-turbine and tip-jet driven rotor systems are on about a third of the current American helicopter types, the corresponding proportion among the British types is nearer two-thirds.

As one would expect, at present the majority of the World's helicopters are still powered by single engines. There are signs, however, that the multi-engined types are on the increase. Here one finds that proportionately Great Britain has a larger offering of multi-engined helicopters than does America; but such a comparison tends to be misleading unless the large number of single-seaters in the U.S.A. is borne in mind. Even so, subtracting these from America's total still leaves the U.K. with four out of 10 multi-engined helicopters, compared with America's four out of 20-odd.

Finally, it should be noted that the other VTOL types have been kept as a separate section at the end of these data pages. Here are included the tilt-wing and tilting-rotor craft and one finds the extraordinary variety of current types—there are almost as many as there are aircraft included in this general category. Each of these represents a different attack on the overall problem and the best solutions cannot properly be determined until the performances of all these projects have been assessed. Again, it will be found that numerically the American contribution is far and away the biggest.—F.T.M.

International VTOL Survey . . . .

HC-2 HELI-BABY

Czechoslovakia

IT was announced earlier this year that 200 of these ultra-light two-seaters are being built for domestic use and export. Powered by an 83 b.h.p. Praga DH flat-four engine, they are said to combine good handling characteristics with low vibration and noise levels. Operating costs are also low, and the HC-2 will carry a pilot and 220-lb. payload for 62 miles in an hour for a total fuel consumption of 4.85 gallons. It is suitable for the full range of light helicopter applications, and, with its rotor blades removed, can be transported easily by rail or truck.

Dimensions.—Rotor dia., 28 ft. 10 in. overall length, 34 ft. 4 in.; height, 8 ft. 4 in.; disc area, 653 sq. ft.

Weights.—Normal take-off, 1,280 lb.; empty, 838 lb.; disc loading, 1.96 lb./sq. ft.

Performance.—Cruising speed, 62 m.p.h.; rate of climb, 705 ft./min.; service ceiling, 9,950 ft.; range, 93 miles.

SUD-AVIATION S.E.3130 ALOUETTE II

France

PRESENT holder of the international helicopter height record of 36,036 ft., the Alouette II is in large-scale production by Sud-Aviation for all three French services and other military and civil customers. It is also being assembled in the United States by Republic. Powered by a 360 s.h.p. Turboméca Artouste II shaft-turbine, it is equipped normally to carry five persons, but can be adapted for casualty evacuation, flying crane, agricultural, rescue or freight-carrying duties. The military version has completed firing trials with a total of six Nord SS.11 anti-tank guided missiles mounted on booms each side of the cabin. A four-seat executive version named the Gouverneur is available.

Dimensions.—Rotor dia., 33 ft. 6 in.; fuselage length, 31 ft. 9½ in.; height, 9 ft.; disc area, 880 sq. ft.

Weights.—Normal take-off, 3,300 lb.; empty, 1,875 lb.; disc loading, 3.75 lb./sq. ft.

Performance.—Cruising speed, 106 m.p.h.; rate of climb, 880 ft./min.; service ceiling, 10,500 ft.; range, 373 miles.

SUD-AVIATION S.O.1221 DJINN

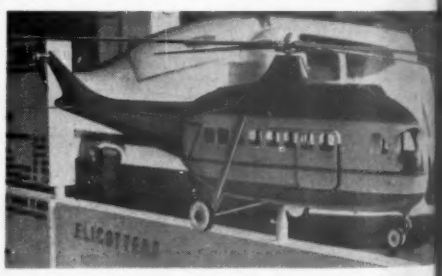
France

THIS two-seat light general-purpose helicopter pioneered the use of "cold-jet" propulsion, in which the rotor is turned simply by ejecting compressed air from the tips without any form of combustion. In the Djinn the air is supplied by a 240 b.h.p. Turboméca Palouste IV compressor. Initial orders for the Djinn included 60 for the French *Aviation Légère d'Artillerie* and others have been acquired in evaluation quantities by the armed forces of the United States and Federal Germany. Air-to-ground firing tests with Nord SS.10 anti-tank guided missiles have been made successfully. The civil version is used extensively for crop-spraying.

Dimensions.—Rotor dia., 36 ft. 1 in.; fuselage length, 17 ft. 4 in.; height, 8 ft. 7 in.; disc area, 1,022 sq. ft.

Weights.—Normal take-off (military), 1,765 lb.; normal take-off (civil), 1,675 lb.; empty, 794 lb.; disc loading (military), 1.73 lb./sq. ft.

Performance (at 1,543 lb.).—Cruising speed, 66 m.p.h.; rate of climb, 690 ft./min.; hovering ceiling with ground effect, 4,900 ft.; range, 112 miles.



Italy

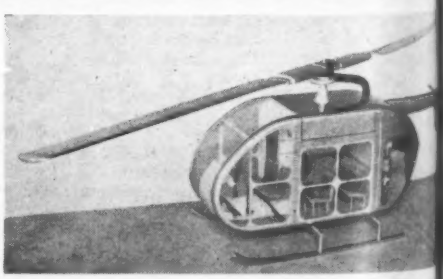
AGUSTA AZ101D

AS well as building under licence the Bell Models 47G and 47J, Agusta are developing prototypes of two helicopters of their own design. One, known as the Model 102, will be a nine-seat general-purpose aircraft in which a 600 b.h.p. Pratt & Whitney R-1340 engine will drive a rotor system based on Bell patents. The second prototype, designated AZ101D, will be a much larger machine, powered by three 750 s.h.p. Turboméca Turmo III shaft-turbines and accommodating up to 27 persons. The data apply to the AZ101D, which is illustrated.

Dimensions.—Rotor dia., 62 ft. 4 in.; overall length, 64 ft.; disc area, 3,045 sq. ft.

Weights.—Normal take-off, 17,085 lb.; empty, 10,000 lb.; disc loading, 5.6 lb./sq. ft.

Performance.—Cruising speed, 127 m.p.h.; rate of climb, 1,150 ft./min.; service ceiling, 18,000 ft.



Italy

FIAT 7002

UNDER construction to meet the requirements of the Italian Air Force, this general-purpose medium-size helicopter utilizes "cold-jet" rotor propulsion of the kind pioneered by the S.O.1221 Djinn. Compressed air expelled from nozzles at the rotor tips is provided by a 530 h.p. Fiat 4700 turbo-generator. This is mounted vertically in the rear of the fuselage, behind the roomy cabin, which has large side-doors and can accommodate five passengers or 88 cu. ft. of freight. Manœuvrability at low forward speeds is ensured by use of a small ducted tail rotor.

Dimensions.—Rotor dia., 39 ft. 4 in.; length of fuselage, 20 ft. 1 in.; height, 9 ft. 5½ in.; disc area, 1,220 sq. ft.

Weights.—Normal take-off, 3,087 lb.; empty, 1,323 lb.; disc loading, 2.53 lb./sq. ft.

Performance.—Cruising speed, 84 m.p.h.; service ceiling, 11,150 ft.; range, 185 miles.

Italy

AER LUALDI L.55

FIRST shown at the 1957 Milan Fair, the L.55 is a neat four-seat light helicopter powered by a 180 b.h.p. Lycoming 0-360 engine. Its two-blade main rotor utilizes the well-proven Hiller Rotor-Matic type of cyclic-pitch control with Lualdi gyro-stabilizer. Engine r.p.m. are kept constant irrespective of the power absorbed by the main rotor, and this helps to make the L.55 unusually simple to fly. Extensive use of reinforced plastics in the projected production version is claimed to offer a great reduction in initial cost.

Dimensions.—Rotor dia., 32 ft. 9½ in.; length, 39 ft.; height, 9 ft. 6 in.; disc area, 845.5 sq. ft.

Weights.—Normal take-off, 2,204 lb.; empty, 1,323 lb.; disc loading, 2.6 lb./sq. ft.

Performance.—Cruising speed, 80 m.p.h.; rate of climb, 984 ft./min.; hovering ceiling, with ground effect, 9,185 ft.; normal range, 240 miles.

Netherlands

NHI H-3 KOLIBRIE

BASIS of the Kolibrie is its "self-adjusting" rotor, which combines extreme simplicity with a high degree of stability. Driven by two tip-mounted ramjets, each of which weighs 20 lb. and gives the equivalent of 60 h.p., the rotor is considerably larger and four times heavier than is usual in this class of helicopter. This results in the accumulation of so much kinetic energy in the rotor that there is up to 10 sec. in which to get into autorotative pitch after an engine failure at low altitude. As a result the two-seat Kolibrie is ideal for crop-spraying (illustrated), dusting and flying crane duties.

Dimensions.—Rotor dia., 33 ft.; length of fuselage, 13 ft. 10½ in.; disc area, 852.2 sq. ft.

Weights.—Normal take-off (military), 1,545 lb.; normal take-off (civil), 1,435 lb.; empty, 530 lb.; disc loading, 1.84 lb./sq. ft.

Performance.—Cruising speed, 60 m.p.h.; inclined climb, 1,200 ft./min.; range (pilot only), 60 miles.

BZ-4 ZUK

Poland

DESIGNED under the leadership of B. Zurakowski, who was responsible for Poland's first successful rotating-wing aircraft, the BZ-4 was first shown in the Aviation Day Exhibition in August, 1956. It is powered by a nationally designed Narkiewicz radial engine of 320 b.h.p. driving a three-blade main rotor surmounted by a three-blade servo-rotor. Seats are normally provided for four persons, but modified versions are planned for crop-spraying, dual-control training and casualty evacuation, carrying one stretcher and a medical attendant.

Dimensions.—Rotor dia., 39 ft. 4½ in.; overall length, 41 ft. 10 in.; height, 8 ft. 6½ in.; disc area, 1,216 sq. ft.

Weights.—Normal take-off, 3,300 lb.; empty, 2,310 lb.; disc loading, 2.71 lb./sq. ft.

Performance.—Cruising speed, 78 m.p.h.; rate of climb, 905 ft./min.; service ceiling, 9,840 ft.; range, 160 miles.

AEROTECNICA AC-12

Spain

FOLLOWING the award of a Spanish Government contract for 12 aircraft of this type, two prototypes were built by the A.I.S.A. company. Like the original Matra-Cantinieau MC–101 from which they were developed, these helicopters have their 150-b.h.p. Lycoming O–320 engine mounted above the cabin, which seats two pilots side by side with dual controls. The three-blade main rotor is driven through a transmission and reduction gear designed on automobile principles and built by the ENHASA propeller company.

Dimensions.—Rotor dia., 27 ft. 10 in.; length of fuselage, 24 ft. 1 in.; height, 9 ft.; disc area, 613.3 sq. ft.

Weights.—Normal take-off, 1,585 lb.; empty, 1,056 lb.; disc loading, 2.58 lb./sq. ft.

Performance.—Cruising speed, 63 m.p.h.; inclined climb, 846 ft./min.; service ceiling, 10,200 ft.; range, 135–200 miles.

Spain

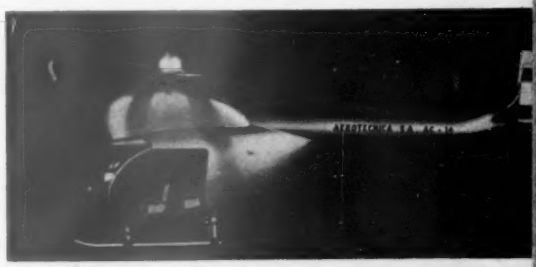
AEROTECNICA AC-14

THE AC–14, of which six are being built by the ENHASA company, is a larger turbine-powered development of the AC–12, utilizing the same general layout. It has a Turboméca Artouste II shaft-turbine, giving 320 s.h.p., plus 175 lb. of residual thrust which is used to increase forward speed in cruising flight and to provide directional control by gas-deflection during vertical flight when the rudders are ineffective. The cabin contains seats for the pilot and four passengers in tandem pairs.

Dimensions.—Rotor dia., 31 ft. 6 in.; length of fuselage, 27 ft. 1 in.; height, 10 ft. 2 in.; disc area, 778.8 sq. ft.

Weights.—Normal take-off, 2,645 lb.; empty, 1,380 lb.; disc loading, 3.39 lb./sq. ft.

Performance.—Cruising speed, 75 m.p.h.; inclined climb, 910 ft./min.; service ceiling, 20,830 ft.



U.S.A.

BELL MODEL 47G

WELL over 2,000 Model 47 helicopters have been built by Bell since January, 1947, and military orders will keep the latest versions in production at least into 1960. Basic current model is the side-by-side three-seat 47G with a 200-b.h.p. Franklin engine. This is in service with the U.S. Army as the H–13G Sioux, for general utility and casualty evacuation duties, and with the U.S. Navy as the HTL–6 trainer. The Model 47G–2 (H–13H) is similar except for its 260-b.h.p. (derated to 200 b.h.p.) Lycoming VO–435 engine, which enables max. power to be maintained to 5,000 ft. Optional accessories include pontoons, night-flying equipment, agricultural spraying and dusting equipment, dual controls and external cargo sling. Data apply to 47G.

Dimensions.—Rotor dia., 35 ft. 1½ in.; length of fuselage, 27 ft. 4 in.; height, 9 ft. 5 in.; disc area, 965 sq. ft.

Weights.—Normal take-off, 2,350 lb.; empty, 1,435 lb.; disc loading, 2.44 lb./sq. ft.

Performance.—Cruising speed 70 m.p.h.; inclined climb, 780 ft./min.; service ceiling, 10,900 ft.; range, 212 miles.

BELL HU-1A IROQUOIS

U.S.A.

DESIGNATED originally H–40, the Iroquois is in production for the U.S. Army for general utility, casualty evacuation and instrument training duties. Its performance and manœuvrability are such that, armed with light rockets and machine-guns, it is also suitable for close support duties in areas where there is natural cover. Power is provided by an 825 s.h.p. (derated to 700 s.h.p.) Lycoming T53 shaft-turbine, driving a three-blade main rotor, with the familiar Bell stabilizing bar mounted above the rotor and an underslung feathering axis hub. The cabin seats six persons.

Dimensions.—Rotor dia., 44 ft.; overall length, 53 ft.; height, 12 ft.; disc area, 1,520 sq. ft.

Weights.—Max. take-off, 5,800 lb.; empty, 3,791 lb.; disc loading, 3.8 lb./sq. ft.

Performance.—Max. speed, 141 m.p.h.; inclined climb, 2,100 ft./min.; hovering ceiling, 14,400 ft.; range, 202 miles.

International VTOL Survey . . . .

BELL MODELS 47H and 47J — U.S.A.

TWO "streamlined" versions of the Model 47 are in production, with enclosed engine-bay and tail-boom. Of these, the 47H Bellairus (illustrated) is a 47G equipped to V.I.P. standards. The 47J Ranger has a longer cabin with the pilot seated centrally in front and a bench-type seat for three persons. Removal of the passenger seat makes room for freight or two stretchers and a seat for a medical attendant. Variants are two specially furnished H–13J V.I.P. transports for Presidential use, the standard HUL–1 for utility and ice-breaker patrol duties with the U.S. Navy, and the Navy's HTL–7 for basic flying and instrument training. The 47J has a 260-b.h.p. (derated to 240 b.h.p.) Lycoming VO–435 engine and data apply to this type.

Dimensions.—Rotor dia., 37 ft. 2 in.; overall length, 43 ft. 4 in.; height, 9 ft. 4 in.; disc area, 1,085 sq. ft.

Weights.—Normal take-off, 2,800 lb.; empty, 1,618 lb.; disc loading, 2.58 lb./sq. ft.

Performance.—Cruising speed, 100 m.p.h.; service ceiling, 17,000 ft.; range, 200 miles.

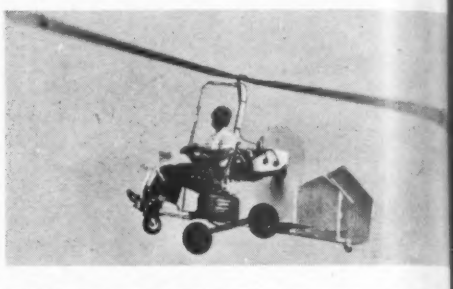
BENSEN B-8M GYRO-COPTER — U.S.A.

BASIC model of the Bensen range is the B–7 Gyro-Glider, a simple unpowered single-seat rotor-kite intended for towing behind a motorcar. It becomes the B–8W Hydro-Glider when fitted with two glass-fibre floats for towing behind a motor-boat. A variant of this marine version is the B–7B Gyro-Boat, in which the basic rotor-kite is mounted on any standard small dinghy, taking off under tow at a forward speed of 23 m.p.h. The B–8M Gyro-Copter is a powered gyroplane conversion of a B–7, with a 72-b.h.p. McCulloch 4318E flat-four engine and a mechanical drive for temporary pre-rotation of the rotor to reduce the take-off run to 50 ft. All are sold in plan and kit form. Data refer to B–8M Gyro-Copter.

Dimensions.—Rotor dia., 20 ft.; length of fuselage, 11 ft. 4 in.; height, 6 ft. 3 in.; disc area, 314 sq. ft.

Weights.—Normal take-off, 500 lb.; empty, 247 lb.; disc loading, 1.6 lb./sq. ft.

Performance.—Cruising speed, 60 m.p.h.; inclined climb, 2,000 ft./min.; service ceiling, 16,500 ft.; range, 100 miles.



BRANTLY B-2 — U.S.A.

AFTER the prototypes had completed five years of development flying, the U.S. Army ordered an evaluation batch of five B–2s in 1958, under the designation of YHO–3. These are expected to be similar to the second prototype (illustrated), which is fitted out as a side-by-side two-seater with a 162-b.h.p. Lycoming VO–360 flat-four engine. A unique feature of the main three-blade rotor is that each blade has a flapping hinge offset 2.67 in. from the hub, with further coincident flapping and lag hinges at approximately 40% of the blade span. The blades are heavy enough to "store" considerable kinetic energy for power-off landings.

Dimensions.—Rotor dia., 23 ft. 9 in.; length, 21 ft. 9 in.; height, 7 ft.; disc area, 442 sq. ft.

Weights.—Normal take-off, 1,600 lb.; empty, 960 lb.; disc loading, 3.62 lb./sq. ft.

Performance.—Cruising speed, 100 m.p.h.; inclined climb, 1,200 ft./min.; range, 270 miles.

CESSNA YH-41 SENECA — U.S.A.

A FORMER holder of the international helicopter height record, at 30,355 ft., the YH–41 is a four-seat general-purpose helicopter with a high performance and several unique design features. Its 270-b.h.p. Continental FSO–526 supercharged engine is mounted in the fuselage nose to improve accessibility and cooling, and provide more room for passengers or cargo amidships. The blades of the two-blade main rotor are attached to the hub through flexible L-section sheet steel hinges, which permit continuously varying pitch without the use of pitch-change bearings; and there are only three gears in the main transmission. Ten YH–41s have been delivered to the U.S. Army.

Dimensions.—Rotor dia., 35 ft.; length of fuselage, 32 ft. 8 in.; height, 7 ft. 2 in.; disc area, 960 sq. ft.

Weights.—Normal take-off, 3,000 lb.; empty, 2,050 lb.; disc loading, 3.12 lb./sq. ft.

Performance.—Cruising speed, 100–120 m.p.h.; inclined climb, 1,030 ft./min.; hovering ceiling, 14,500 ft.; range, 265 miles.

DE LACKNER AEROCYCLE — U.S.A.

INTENDED for military use as a "flying motorcycle," this one-man helicopter is claimed to be so simple to fly that ordinary soldiers have learned to control it in 20 min. It consists basically of a small platform, carrying the pilot and 40-b.h.p. Kiekhaefer Mercury two-stroke outboard motor, mounted above a pair of chain-driven contra-rotating rotors of 15-ft. diameter. Controls comprise handlebars to turn the Aerocycle in any required direction, and a twist-grip throttle. To change course in flight the pilot simply leans in the direction he wants to go. Two U.S. gallons of fuel are carried in the column supporting the handlebars, and the pilot is strapped lightly to this column by a webbing belt. Skids or a pontoon undercarriage can be fitted.

Dimensions.—Rotor dia., 15 ft.; disc area, 177 sq. ft.

Weights.—Normal take-off, 500 lb. approx.; disc loading, 2.83 lb./sq. ft.

Performance.—Cruising speed, 75 m.p.h.; range, 50 miles.

DOMAN LZ-5-2 — U.S.A.

THIS general-purpose helicopter features a unique hingeless rotor in which the blades are dynamically flexible but otherwise unarticulated. The hub is gimbal-mounted and is contained in a common housing with the reduction gearing and swashplate, with circulating oil lubrication for all moving parts. Powerplant of the LZ–5–2 is a 400-b.h.p. Lycoming SO–580 piston-engine, mounted in the nose. This helicopter can carry six passengers, four stretchers or equivalent freight, in addition to a crew of two. For agricultural or flying crane duties, the fuselage skin and other non-structural components can be stripped off to raise the payload to 2,250 lb.

Dimensions.—Rotor dia., 48 ft.; length of fuselage, 37 ft. 10 in.; height, 10 ft. 5 in.; disc area, 1,810 sq. ft.

Weights.—Normal take-off, 5,200 lb.; empty, 3,250 lb.; disc loading, 2.87 lb./sq. ft.

Performance.—Cruising speed, 81 m.p.h.; inclined climb, 850 ft./min.; service ceiling, 11,500 ft.; range, 383 miles.

(*Continued on page* 861)

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GLUHAREFF HELICOPTERS — U.S.A.

THREE different types of one-man helicopter are being developed by the Gluhareff company, powered in each case by rotor tip-mounted pressure-jets which give 18 lb. s.t. for an installed weight of 5½ lb. Simplest of these machines is a strap-on helicopter known as the MEG–1X, which consists of a central pylon structure carrying at the bottom cylinders of propane fuel and compressed air, and at the top a single-blade rotor with counterweight. The MEG–2X is similar except that it has a two-blade rotor and twice as much power. It was expected to begin flight trials in 1958 together with the MEG–3X, which has an identical rotor system but is arranged as a "flying-platform" with the pilot standing above the rotor. Data apply to the MEG–1X.

Dimensions.—Rotor swept dia., 20 ft.; disc area, 314 sq. ft.

Weights.—Normal take-off, 260 lb.; empty, 60 lb.; disc loading, 0.83 lb./sq. ft.

Performance.—Max. speed, 55 m.p.h.; hovering ceiling, 4,500 ft.

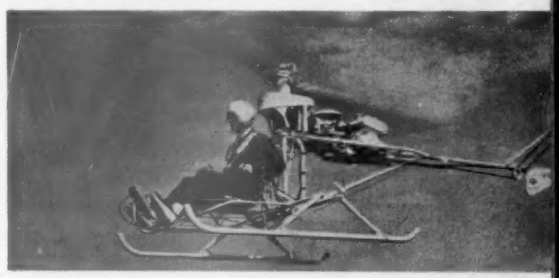
GOODYEAR GA-400R-3 GIZMO — U.S.A.

THE object in designing the private-venture GA–400R was to produce an ultra-light courier-liaison or tactical vehicle suitable for any task that requires the transport of one man at up to 70 m.p.h. Since it flew for the first time on May 9, 1954, it has undergone continuous development, and in its latest form it is powered by a 38-b.h.p. Johnson 35 two-stroke engine, which drives the two-blade main rotor through a belt and pulley system. The airframe is of welded aluminium tubing, with undercarriage skids of the same material carried on a steel outrigger structure.

Dimensions.—Rotor dia., 20 ft.; length of fuselage, 21 ft.; height, 7 ft.; disc area, 314 sq. ft.

Weights.—Normal take-off, 490 lb.; disc loading, 1.56 lb./sq. ft.

Performance.—Cruising speed, 50 m.p.h.; inclined climb, 500 ft./min.; service ceiling 12,000 ft.; range, 50 miles.



GYRODYNE XRON-1 ROTOCYCLE — U.S.A.

THIS ultra-light single-seater was designed to meet a U.S. Marine Corps requirement for a simple helicopter for observation, liaison and small unit tactical manœuvres which could be collapsed easily into a small package for transportation and assembled quickly in the field by one man. When it proved successful in the official design competition, Gyrodyne built and flew the prototype in less than a year. Since then the versatility and performance of the XRON–1 have been improved by substituting a 60-b.h.p. Porsche engine for the 40-b.h.p. Nelson originally fitted, and it is hoped eventually to offer the Rotocycle for civil as well as military use.

Dimensions.—Rotor dia., 17 ft.; length of fuselage, 11 ft.; height, 7 ft. 3 in.; disc area, 227 sq. ft.

Weights.—Normal take-off, 645 lb. (including 180 lb. pilot and 60 lb. pack); disc loading, 2.84 lb./sq. ft.

Performance.—Max. speed, 73 m.p.h.; inclined climb, 945 ft./min.; service ceiling, 10,400 ft.; range, 26.5 miles.

HILLER XROE-1 — U.S.A.

THIS one-man helicopter completed its official flight test programme in July, 1957, and was designed originally to meet a U.S. Marine Corps requirement. Of extremely simple design, it can be folded by one person into a small package for transportation in a matter of minutes by withdrawing 13 standard quick-release pins. Power unit is a 45-b.h.p. Nelson H–63 four-cylinder two-stroke engine, which drives a two-blade main rotor incorporating the familiar Hiller Rotor-Matic control system. It was announced recently that the XROE–1 is to be built in Britain by Saunders-Roe, five aircraft from the initial series being earmarked for evaluation by the U.S. Marines.

Dimensions.—Rotor dia., 18 ft. 6 in.; height, 6 ft. 11 in.; disc area, 268 sq. ft.

Weights.—Normal take-off, 556 lb.; empty, 300 lb.; disc loading, 2.08 lb./sq. ft.

Performance.—Cruising speed, 52 m.p.h.; inclined climb, 1,160 ft./min.; service ceiling, 13,200 ft.; range, 166 miles.

HILLER HJ-1 HORNET — U.S.A.

WHEN the Hiller 8RJ2B ramjet engines (each 40 lb. s.t.) of this tiny two-seat helicopter were awarded an Approved Type Certificate by the C.A.A. in October, 1954, they became the first tip-mounted powerplants for helicopters to be certificated in the United States. Since then Hiller have had no opportunity to produce a civil version of the Hornet, but 12 have been procured by the U.S. Army under the designation of YH–32 and three by the U.S. Navy as the HOE–1. A special stripped-down version known as the YH–32A (ULV) has also been tested recently by the U.S. Army Ordnance Corps as a firing platform for air-to-ground rockets.

Dimensions.—Rotor dia., 23 ft. 8 in.; length, 23 ft.; height, 7 ft. 10 in.; disc area, 440 sq. ft.

Weights.—Normal take-off, 1,080 lb.; empty, 544 lb.; disc loading, 2.45 lb./sq. ft.

Performance.—Cruising speed, 69 m.p.h.; inclined climb, 700 ft./min.; service ceiling, 6,900 ft.; range, 28 miles.

HILLER H-23D RAVEN — U.S.A.

A TOTAL of more than 900 civil and military helicopters of this basic type had been delivered by mid-1958, and many different versions are in service with the U.S. Army and Navy under the designations of H–23 Raven and UH–E respectively. The current military version is the H–23D (to which the data apply) with a 250-b.h.p. Lycoming VO–435 engine and a transmission designed for 1,000 hours between overhauls. Used for a multitude of missions, including observation, light utility, casualty evacuation and primary flying training, it will be kept in production well into 1959 to meet current orders. Civil counterpart is the new high-performance Model 12E with 305-b.h.p. Lycoming engine.

Dimensions.—Rotor dia., 35 ft.; fuselage length, 27 ft. 9½ in.; height, 10 ft. 1½ in.; disc area, 985 sq. ft.

Weights.—Normal take-off, 2,700 lb.; empty, 1,780 lb.; disc loading, 2.74 lb./sq. ft.

Performance.—Cruising speed, 82 m.p.h.; inclined climb, 1,050 ft./min.; service ceiling, 13,200 ft.; range, 205 miles.

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HUGHES MODEL 269A

U.S.A.

DESIGN work on this two-seat light helicopter was started as a private venture in September, 1955, with the emphasis on simplicity to keep down initial and operating costs. The first prototype was flown only 13 months later and soon displayed remarkable stability and handling qualities. As a result, it was demonstrated in 1956 to the U.S. Army and an evaluation batch of five Model 269As has since been ordered under the designation YHO-2. Each will be powered by a 180-b.h.p. Lycoming O-360 four-cylinder piston-engine, driving a three-blade main rotor with fully-articulated metal blades.

Dimensions.—Rotor dia., 25 ft.; length of fuselage, 22 ft. 4 in.; height, 8 ft. 4 in.; disc area, 491 sq. ft.

Weights.—Normal take-off, 1,550 lb.; empty, 890 lb.; disc loading, 3.16 lb./sq. ft.

Performance.—Cruising speed, 75 m.p.h.; inclined climb, 1,360 ft./min.; range, 150 miles.

KAMAN HU2K-1

U.S.A.

FIRST Kaman type to break away from the company's traditional intermeshing-rotor configuration, the HU2K-1 was the winner of an important U.S. Navy design competition for a utility helicopter, and four prototypes are now under construction. Illustrated here in mock-up form, it has a very clean design, with a tailwheel undercarriage, and is powered by an 1100 s.h.p. General Electric T58 shaft-turbine. The four-blade main rotor is of all-metal construction, and is fitted with servo-flaps to eliminate the need for blade pitch change and the associated hinges. No details of the size, weight or performance of the HU2K-1 may yet be published.

KAMAN K-17

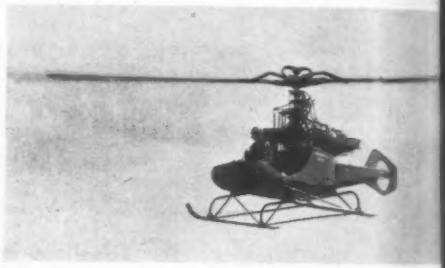
U.S.A.

FLOWN for the first time in the spring of 1958, the K-17 is a two-seat ultra-light helicopter with a "cold-jet" rotor and has been developed as a joint U.S. Army-Kaman project. It is powered by a 400-s.h.p. Blackburn-Turboméca Turmo 600 engine, which drives a Boeing 502 compressor. Air from the compressor is ducted through the hollow rotor blades and ejected from the tips, without any form of combustion, to drive the rotor. As in all Kaman designs, each rotor blade is fitted with a small servo-flap instead of the usual pitch-change bearings.

Dimensions.—Not available.

Weights.—Empty, approx. 1,000 lb.; payload, 700 lb.

Performance (approx.).—Cruising speed, 92 m.p.h.; inclined climb, 1,260 ft./min.; hovering ceiling, 5,000 ft.; range, 200 miles.



KAMAN HOK-1

U.S.A.

THE initial production version of this helicopter was the general-purpose 4/5-seat HOK-1, which was ordered by the U.S. Navy in 1950. Delivery of the HOK-1 to the U.S. Marine Corps is continuing side by side with the similar HUK-1 for the U.S. Navy. In addition, the U.S.A.F. has ordered a version designated H-43A for local crash-rescue duties, carrying pilot, rescue crew of three and fire-fighting equipment. All versions are powered by a 600-b.h.p. Pratt & Whitney R-1340-48 engine, mounted at an angle of 35 degrees from the horizontal at the rear of the fuselage and driving intermeshing two-blade rotors with servo-flap control.

Dimensions.—Rotor dia., 47 ft.; length of fuselage, 25 ft.; height, 15 ft. 6½ in.; disc area, 3,470 sq. ft.

Weights.—Normal take-off, 5,800 lb.; empty, 4,040 lb.; disc loading, 1.67 lb./sq. ft.

Performance.—Cruising speed, 58–75 m.p.h.; inclined climb, 1,300 ft./min.; service ceiling, 18,000 ft.; range, 220 miles.

KAMAN H-43B

U.S.A.

IN 1956, Kaman modified an HOK-1 as a test-bed for the first flight trials of the Lycoming XT53 shaft-turbine. It was soon found that the lighter weight and higher power of this engine, combined with the fact that it was mounted above the fuselage, enabled the usable cabin space to be doubled, giving a payload of seven passengers, four stretchers and attendant or equivalent freight. Both civil and military production versions are projected, of which the first will be the H-43B crash-rescue helicopter for the U.S.A.F. This will be generally similar to the H-43A, but with an 825 s.h.p. T53 engine. One HOK-1 has also been re-engined with a Blackburn-Turboméca Twin Turmo 600 shaft-turbine.

Dimensions.—Same as HOK-1.

Weights.—Not available.

Performance.—Max. speed, over 132 m.p.h.

McDONNELL MODEL 120

U.S.A.

DESPITE its small size, the single-seat McDonnell Model 120 has demonstrated the possibilities of turbine-powered flying crane helicopters to a remarkable degree, by lifting more than 1¼ times its own empty weight on a pilot-operated hook. Of the simplest-possible construction, it is powered by three AiResearch GTC-85-35 turbo-compressors, which supply compressed air for the pressure-jet burners built into the tips of the three-blade rotor. It will maintain height with one engine out.

Dimensions.—Not available.

Weights.—Empty, 2,400 lb.; payload, 3,900 lb.

Performance.—Range with full load, 80 miles.

U.S.A.

MONTE-COPTER MODEL 12

DEVELOPMENT of this light helicopter began in 1955 with the two-seat Model 10, which was powered by a 135-b.h.p. Lycoming O–290–D2 engine, driving a two-blade rotor with servo-control surfaces mounted at 90 degrees to the blades. The Model 10 had small fixed wings to off-load the rotor in flight and was fitted with a tail-boom carrying twin fins. It was later modified into the Model 10A by removal of the wings and cabin skin and replacement of the piston-engine by two Continental Model 140 (Turboméca Palouste) air compressors, mounted on each side of the fuselage and supplying compressed air to rotor-tip pressure jets. Further modification of the airframe has now produced the Model 12, with cabin covering replaced and a single rudder working in the jet efflux instead of the former tail-boom.

Dimension.—Rotor dia., 32 ft.

Weights.—Normal take-off, 1,400 lb.; empty, 1,000 lb.; disc loading, 1.74 lb./sq. ft.

Performance.—Not available.

NAGLER NH-160

U.S.A.

THIS experimental single-seat helicopter has an entirely new type of rotor system. Its 72-b.h.p. McCulloch 4318A engine is suspended in bearings which allow complete rotation. This enables the two-blade upper rotor and the three-blade lower rotor (between the undercarriage support tubes) to be driven directly by extension shafts from the crankcase and crankshaft respectively, and eliminates the need for transmission, gearbox or drive-belt Most of the lift is provided by the lower rotor, with the upper one providing anti-torque reaction and control through a conventional swashplate. Its limited rôle enables the lightly loaded upper rotor to be operated at low angles of attack.

Dimensions.—Upper rotor dia., 20 ft. 7 in.; lower rotor dia., 8 ft. 1 in.; overall length, 21 ft. 11 in.; height, 7 ft.

Weights.—Normal take-off, 660 lb.; empty, 500 lb.

Performance.—Not available.

U.S.A.

OMEGA BS-12

ONE of the first specially designed flying crane helicopters to fly, on December 26, 1956, the Omega BS–12 is expected to receive C.A.A. certification by the end of this year. It is powered by two 225-b.h.p. Franklin (eventually 310-b.h.p. Lycoming) engines, mounted on each side of the rotor pylon and driving a four-blade main rotor. Loads of up to 1,000 lb. can be hauled in the space between the cabin and rear wheels, under the CG. Alternatively, the BS–12 will carry a mixed load of up to four passengers and reduced freight. It will fly on one engine and can be fitted with Reaction Motors rotor-tip rockets for higher take-off performance.

Dimensions.—Rotor dia., 39 ft.; length of fuselage, 36 ft.; height, 13 ft.; disc area, 1,194.6 sq. ft.

Weights.—Normal take-off, 4,565 lb.; empty, 3,125 lb.

Performance.—Cruising speed, 77 m.p.h.; inclined climb, 1,000 ft./min.; service ceiling, 12,400 ft.; endurance, 2½ hours.

U.S.A.

ROTOR-CRAFT RH-1 PINWHEEL

DESIGNED as a simple, practical vehicle to carry a fully equipped soldier at about 60 m.p.h., the Pinwheel is powered by Rotor-Craft R–1 rotor-tip rockets which weigh less than 1 lb. each but give over 20 lb. s.t. when operated on H.T.P. monopropellent. It consists basically of a pylon carrying a two-blade metal folding rotor on a fully articulated hub, a light boom for the tail rotor and a cross-boom at the base supporting the pilot's seat and fuel tanks. Controls comprise a collective-pitch stick with twist-grip throttle, and a hanging cyclic-pitch column which is twisted to steer the helicopter by changing the pitch of the tail rotor.

Dimensions.—Rotor dia., approx. 16 ft.; overall length, 8 ft.; height, pilot standing, 8 ft.; disc area, approx. 200 sq. ft.

Weights (approx.).—Normal take-off, over 400 lb.; empty, 165 lb.; disc loading, over 2.0 lb./sq. ft.

Performance.—Cruising speed, 60–70 m.p.h.

SIKORSKY S-56

U.S.A.

COMPARABLE in size with a DC-3, the S–56 is the largest U.S. helicopter yet built in series, and the 100th aircraft of this type was completed on August 27 this year. It is in service as a troop and cargo transport with the U.S. Army under the designation of H–37A Mojave, and with the U.S. Marine Corps as the HR2S–1. Power is provided by two 2,100-b.h.p. (restricted to 1,725 b.h.p.) Pratt & Whitney R–2800 engines, mounted at the end of short stub wings in nacelles which house also the retracted main wheels. The army version carries a crew of three and 23 passengers, 24 stretchers or 1,900 cu. ft. of cargo, which is loaded through clamshell nose-doors. An HR2S–1 holds the helicopter speed record of 162.7 m.p.h.

Dimensions.—Rotor dia., 72 ft.; length of fuselage, 82 ft. 10 in.; height, 22 ft.; disc area, 4,070 sq. ft.

Weights (HR2S–1).—Normal take-off, 31,000 lb.; empty, 21,069 lb.; disc loading, 7.62 lb./sq. ft.

Performance.—Cruising speed, 115 m.p.h.; inclined climb, 1,390 ft./min.; service ceiling, 8,000 ft.; combat radius, 104 miles.

SIKORSKY S-58

U.S.A.

HOLDER of international helicopter speed records over 100 km. (141.9 m.p.h.), 500 km. (136 m.p.h.) and 1,000 km. (132.6 m.p.h.), the S–58 is a medium-size general-purpose helicopter powered by a 1,525-b.h.p. Wright R–1820 engine. The commercial S–58C used by Sabena and other airlines carries 12–18 passengers or eight stretchers. Military versions are the anti-submarine HSS–1N for the U.S. Navy, with automatic stabilization and hover coupler; the HUS–1 for the Marine Corps; and the H–34 Choctaw for the U.S. Army. An HSS–1 has been fitted experimentally with two General Electric T58 shaft-turbines. The 1,000th S–58 was completed on November 12 this year.

Dimensions.—Rotor dia., 56 ft.; length of fuselage, 47 ft. 2 in.; height, 14 ft. 4 in.; disc area, 2,460 sq. ft.

Weights.—Normal take-off, 13,000 lb.; empty, 7,560 lb.; disc loading, 5.29 lb./sq. ft.

Performance.—Cruising speed, 101 m.p.h.; inclined climb, 1,150 ft./min.; service ceiling, 9,600 ft.; range, 190 miles.

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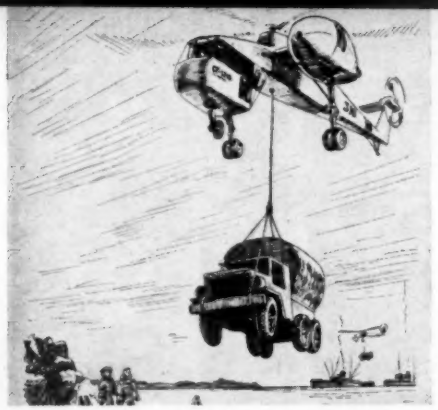


SIKORSKY S-60 U.S.A.

SCHEDULED to fly early in the New Year, the S–60 is a large flying-crane helicopter based on the S–56 and with a payload of 6 tons, carried externally. Produced as a private venture, it will have instead of the usual fuselage a small glass-enclosed cabin for the two-man crew and a high-set girder tail-boom. The pilot's seat will swivel so that he can face rearward to gain a clear view of loading and unloading whilst hovering, a second set of controls being provided in this position. Power plant, rotor blades, heads and transmissions will be standard S–56 components.

Dimensions, weights and performance data are not yet available.

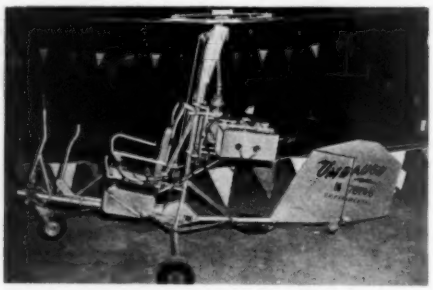
SIKORSKY S-61 and S-62 U.S.A.

THESE two helicopters offer great versatility, as they have been designed as amphibians with flying-boat hulls and stabilizing floats, to permit regular operation from water as well as land. The S–62, which flew for the first time in May of this year, is powered by a 1,050-s.h.p. General Electric T58 shaft-turbine and utilizes the rotor and transmission and other components of the S–55. It can carry 8–12 passengers or an external freight load of 3,000 lb. The larger S–61, with two T58s and a 6,000-lb. payload, is intended for anti-submarine operations with the U.S. Navy under the designation of HSS–2 and troop-carrying duties with the Marines as the HUS–2. It should fly early in 1959. Data apply to S–62.

Dimensions.—Rotor dia., 53 ft.; length of fuselage, 44 ft. 7 in.; height, 14 ft. 2 in.; disc area, 2,206 sq. ft.

Weights.—Normal take-off, 7,500 lb.; empty, 4,409 lb.; disc loading, 3.4 lb./sq. ft.

Performance.—Cruising speed, 92 m.p.h.; inclined climb, 1,160 ft./min.; service ceiling 15,700 ft.



UMBAUGH GYRO-COPTER U.S.A.

THIS single-seater is basically a Bensen Gyro-Copter, but incorporates several refinements. A floor-mounted control column replaces the usual hanging stick, and there is a clutch lever on the port side for rotor pre-rotation. The rotor is fitted with a droop-stop and the fuel tank is re-positioned under the pilot's seat. Powered by a 72-b.h.p. McCulloch two-stroke engine, the prototype has completed some 900 flying hours and 15 production models have been built and sold. A two-seat version with a 180-b.h.p. Lycoming or 175-b.h.p. Continental engine is under development.

Dimensions.—Rotor dia., 20 ft.; disc area, 314 sq. ft.

Weight.—Empty, 240 lb.

Performance.—Not available.

VERTOL HUP-3 RETRIEVER and H-25A ARMY MULE U.S.A.

DELIVERIES of the original HUP–1 version of this helicopter to the U.S. Navy began in 1950. The HUP–2, with 550-b.h.p. Continental R–975 engine, introduced an autopilot, which enabled the tail stabilizing surfaces of the HUP–1 to be deleted; and this model is still used extensively for plane guard, rescue and general utility duties. It was followed in 1953 by the H–25A transport version for the U.S. Army, with hydraulically boosted controls, strengthened cabin floor and modifications to speed stretcher loading; and the final HUP–3 was a naval counterpart of the H–25A. Altogether 339 of the HUP series were built before production ended in July, 1954. Data apply to H–25A.

Dimensions.—Rotor dia., each 35 ft.; length of fuselage, 32 ft.; height, 12 ft. 6 in.; disc area, (each), 960 sq. ft.

Weights.—Normal take-off, 5,750 lb.; empty, 3,928 lb.; disc loading, 3.0 lb./sq. ft.

Performance.—Cruising speed, over 80 m.p.h.; inclined climb, 1,000 ft./min.; service ceiling, over 10,000 ft.; max. range, 340 miles.

VERTOL H-21 and MODEL 44 U.S.A.

THE military H–21 is flying with the U.S.A.F. (as the Work Horse), U.S. Army (as the Shawnee) and several foreign services on general transport and rescue duties. The original H–21A had a derated 1,150-b.h.p. Wright R–1820–103 engine and accommodation for 14 troops; but the full engine power of 1,425 b.h.p. is used in the H–21B and C, which can carry 20 troops or 12 stretchers. Civil versions of the H–21 are the Model 44A 19-seat utility transport, the 14/15-seat Model 44B (illustrated) furnished to airline standards, and the Model 44C executive transport.

Turbine-powered prototypes are flying as the H–21D with two General Electric T58s and Model 105 with two Lycoming T53s. Data apply to Model 44.

Dimensions.—Rotor dia., each 44 ft.; length of fuselage, 52 ft. 6 in.; height, 15 ft. 5 in.; disc area (each), 1,520 sq. ft.

Weights.—Normal take-off, 14,350 lb.; empty, 8,990 lb.; disc loading, 4.72 lb./sq. ft.

Performance.—Cruising speed, 101 m.p.h.; inclined climb, 1,050 ft./min.; hovering ceiling with ground effect, 5,400 ft.; range, 280 miles.

VERTOL MODEL 107 U.S.A.

FIRST flown in April of this year, the Model 107 has been designed specifically to take advantage of the saving in weight and space made possible by the use of turbine engines, and is much shorter than the H–21 series. It is available in both military and civil forms, and the U.S. Army has ordered 10 under the designation of YHC–1. Of these, seven will have twin 1,025-s.h.p. General Electric T58 shaft-turbines, the others twin 825-s.h.p. Lycoming T53s. Accommodation will be provided for 23 troops, 15 stretchers or up to 2½ short tons of freight. The civil version will carry up to 30 passengers in its high-density configuration.

Dimensions.—Rotor dia., each 48 ft. 4 in.; overall length (blades folded), 44 ft. 3½ in.; height, 17 ft. 7½ in.; rotor area (each), 1,830 sq. ft.

Weights.—Normal take-off, 15,500 lb.; empty, 9,100 lb.; disc loading, 4.25 lb./sq. ft.

Performance.—Max. speed, 160 m.p.h.

(Continued on page 865)

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Soviet Union **KAMOV Ka-15**

FIRST reported in 1956, this two-seat light helicopter showed its capabilities on May 29, 1958, by setting up an international speed record of 101.15 m.p.h. over a 100-km. closed circuit near Moscow. It is powered by a 255 b.h.p. AI-14R nine-cylinder supercharged radial engine, driving two contra-rotating three-blade wooden rotors. Pilot and passenger are seated side by side in a totally enclosed cabin.

Dimensions.—Rotor dia., 32 ft. 8½ in.; disc area, 840 sq. ft.

Weights.—Normal take-off, 2,805 lb.; disc loading, 3.34 lb./sq. ft.

Performance.—Cruising speed, 78 m.p.h.; service ceiling, 9,840 ft.; normal range, 195 miles.

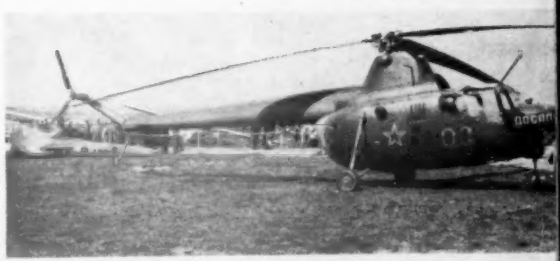
Soviet Union **KAMOV Ka-18**

FIRST flown in mid-1957, the Ka-18 utilizes the same engine and rotor system as the Ka-15, but has a redesigned and lengthened front fuselage to provide accommodation for four persons. It is in series production and will be used for a wide variety of duties including passenger, freight and mail carrying, geographic survey and agricultural dusting and spraying. It can be fitted with long-range tanks to increase its range to 435 miles.

Dimensions.—Rotor dia, 32 ft. 8½ in.; length of fuselage, 23 ft.; height, 10 ft. 10 in.; disc area, 840 sq. ft.

Weights.—Normal take-off, 2,890 lb.; empty, 2,255 lb.; disc loading, 3.44 lb./sq. ft.

Performance.—Cruising speed, 68 m.p.h.; normal range, 105–248 miles.



Soviet Union **MIL Mi-1 and Mi-3**

STANDARD light helicopter of Aeroflot and the Soviet armed forces, the four-seat Mi-1 was first flown in 1950 and entered service in the following year. Several variants exist, of which the most important are the three-seat Mi-1T and the multi-purpose Mi-1NKh for postal, ambulance and agricultural duties. All are powered by a 575 b.h.p. AI-26V radial engine, driving a three-blade rotor, and the same basic type is being produced in quantity in Poland under the designation of SM-1. A later development is the Mi-3, which introduced many refinements, including a more efficient four-blade rotor and external panniers for stretchers, freight, fuel or agricultural chemicals.

Dimensions.—Rotor dia., 45 ft. 11 in.; length of fuselage, 39 ft. 8 in.; height, 10 ft. 10 in.; disc area, 1,650 sq. ft.

Weights.—Normal take-off, 4,960 lb.; empty, 3,925 lb.; disc loading, 3.01 lb./sq. ft.

Performance (SM-1).—Cruising speed, 60 m.p.h.; inclined climb, 1,280 ft./min.; hovering ceiling, 3,850 ft.; max. range, 240 miles.

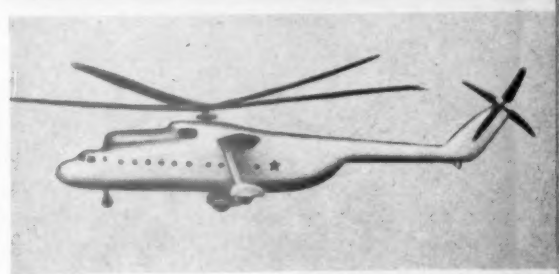
Soviet Union **MIL Mi-4**

THE similarity of the Mi-4's layout to that of the Sikorsky S-55 tends to disguise the fact that it is a much larger and more powerful aircraft. Fitted with a nose-mounted 1,700 b.h.p. ASh-82V radial engine, the civil Mi-4P carries a crew of two and 10 passengers. It is used widely by Aeroflot, as is the agricultural Mi-4S in which the underfuselage pannier houses chemicals. The military Mi-4, also in service in very large numbers, can accommodate 14 troops; a Jeep-type vehicle; a 76-mm. anti-tank gun; or two motorcycle and sidecar combinations, which are loaded through rear clamshell doors.

Dimensions.—Rotor dia., 68 ft. 11 in.; length of fuselage, 53 ft. 5 in.; height, 17 ft.; disc area, 3,710 sq. ft.

Weights.—Normal take-off, 15,875 lb.; payload, 2,650 lb.; disc loading, 4.28 lb./sq. ft.

Performance.—Cruising speed, 99 m.p.h.; service ceiling, 16,000 ft.; range, 250 miles.



Soviet Union **MIL Mi-6**

LARGEST and heaviest helicopter yet flown anywhere in the World, the Mi-6 was announced in the autumn of 1957, together with the news that on October 30 of that year it had set up two international records. In the first of these it lifted 10,000 kg. (22,046 lb.) to a height of 7,979 ft., followed by a climb to 7,874 ft. with a 12,000 kg. (26,964 lb.) load. The Mi-6 is powered by two 4,700 s.h.p. Soloviev TB-2BM shaft-turbines, mounted side by side above the forward part of its cabin and driving a five-blade main rotor and four-blade tail rotor. In the latest version small fixed wings are provided to off-load the main rotor in flight. Normal accommodation is stated to be for 70–80 passengers, with maximum seating for 120.

Dimension.—Rotor dia, approx. 110 ft.

Weights and Performance.—Not available.

Soviet Union **YAKOVLEV YAK-24**

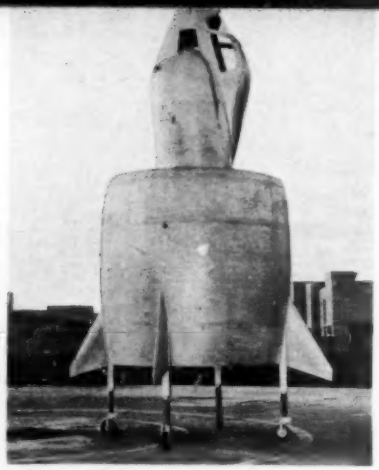
UNTIL the Mi-6 enters service, the twin-engined Yak-24 remains the largest helicopter yet built in quantity. Development was speeded by the fact that it utilizes the same type of 1,700 b.h.p. ASh-82V engine, rotor and transmission system as the Mi-4; and it was first shown in the 1955 Aviation Day display at Tushino, when formations of Yak-24s landed and disgorged various military loads. These can include up to 40 troops; three trucks; or a Jeep-type vehicle towing a twin-barrel 14.5-mm. anti-aircraft machine-gun, plus a crew of six. The underside of the upswept rear fuselage is lowered to form a ramp for loading vehicles and heavy freight.

Dimensions.—Rotor dia., each 68 ft. 11 in.; fuselage length, 92 ft.; height, 23 ft.; disc area (each rotor), 3,710 sq. ft.

Weights (approx).—Normal take-off; 35,200 lb.; useful load, 8,800 lb.; disc loading, 4.75 lb./sq. ft.

Performance (estimated).—Cruising speed, 110 m.p.h.; service ceiling, 18,000 ft.; range, 500 miles.

International VTOL Survey . . . .



SNECMA C.450-C1 COLEOPTÈRE

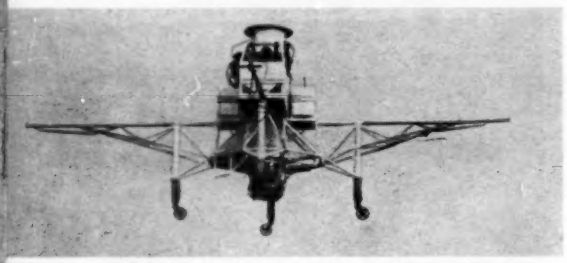
France

THIS unique single-seat tail-sitter is the end product of six years of research with the "Flying Atar," which comprised little more than a SNECMA Atar turbojet carried vertically on four stalky legs and with a seat for the pilot on top. Directional control during vertical flight was achieved by jet deflection, and this system is retained on the C.450, which has a proper enclosed cockpit, with tilting seat, and an annular wing to permit transition into horizontal flight at a safe altitude. Intended for research at subsonic speeds, the C.450 is powered by an 8,155-lb.-s.t. Atar 101E.V turbojet, specially modified for vertical flight.

Dimensions.—Dia. of wing, 10 ft. 6 in.; overall length, 26 ft. 3 in.

Weight.—Normal take-off, approx. 6,175 lb.

Performance.—Not available.



MATVEYEV TURBOLET

Soviet Union

THE existence of this Soviet counterpart of Rolls-Royce's earlier "Flying Bedstead" was first announced in October, 1957. Designed by a team comprising Messrs. Rafaelantz, Kvashnin and Lapshin, under the leadership of Prof. Matveyev, the Turbolet consists of a steel-tube frame surrounding a large vertically mounted axial-flow turbojet and carried on four small castoring wheels. Fuel tanks are mounted on each side of the engine, which is possibly a Mikulin RD-3 of 15,000–20,000 lb. s.t.; and there are differential air-jets at the ends of four long booms to provide control and stability. The interior of the enclosed cockpit is said to resemble that of a MiG-17 fighter.

At the time of the announcement of the Turbolet, it was claimed that Soviet designers are developing other direct jet-lift aircraft, including airliners.

Dimensions, weights and performance data are not available.

U.S.A.

BELL X-14

BUILT at low cost, the X-14 is a research aircraft employing the jet-deflection technique. Thrust diverters behind the two nose-mounted Armstrong Siddeley Viper turbojets can be made to deflect the jet efflux towards the ground, so that the X-14 takes off and lands vertically by direct jet-lift. After take-off, the pilot causes the jet efflux to be directed gradually rearward to produce forward thrust. Then, when forward speed is high enough for the wings to provide adequate lift, the efflux is allowed to escape horizontally and the X-14 flies as a conventional aeroplane. It made its first transition from hovering to forward flight on May 24 this year, and has been flown at a forward speed of 160 m.p.h.

Dimensions.—Span, 34 ft.; length, 25 ft.; height, 8 ft.

Weights and **Performance.**—Not available.

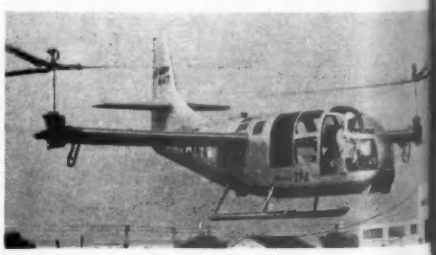
U.S.A.

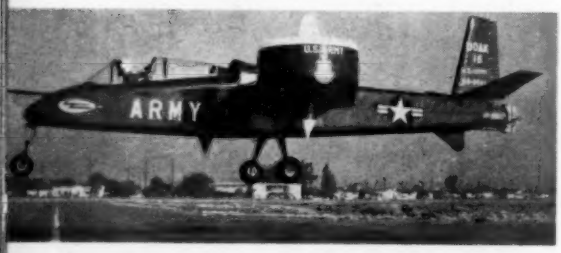
BELL XV-3

DEVELOPED under a joint Army-Air Force contract, the XV-3 is an experimental convertiplane of the tilting-rotor type. It has basically a conventional high-wing monoplane airframe, with a single Pratt & Whitney R-985 engine, driving a two-blade rotor-propeller at each wing tip. For take-off and landing the rotors work in a horizontal plane, enabling the aircraft to function as a conventional helicopter. At height, the rotors are intended to be tilted forward and downward electrically through 90 degrees to work as propellers during cruising flight, with the wings supplying all necessary lift. Complete transitions have been made in a full-scale wind-tunnel, and 15-degree conversions have been made in flight. An earlier version (illustrated) had three-bladed rotors.

Dimensions.—Rotor dia., each 25 ft.; span, 30 ft.; length, 30 ft.; height, 13 ft. 6 in.; disc area, each 982 sq. ft.

Weights and **Performance.**—Not available.





DOAK MODEL 16

U.S.A.

THE two-seat Doak Model 16 features a variation of the tilting-rotor technique by having a ducted propeller at each wing tip. The ducts can rotate through 90 degrees, so that the propellers function as helicopter rotors during take-off and landing. Of conventional steel-tube construction, the Model 16 is powered by an 840-s.h.p. Lycoming T53 shaft-turbine, and has horizontal and vertical vanes positioned in the jet efflux to assist control during vertical and low-speed flight. Ground tests of the prototype began in February of this year, and, following initial hovering trials, it has been sent to Edwards AFB for its main flight development programme.

Dimensions.—Span, 16 ft.; length, 32 ft.; height, 10 ft.

Weights.—Normal take-off, 2,600 lb.; empty, 2,000 lb.

Performance.—Not available.

HILLER X-18

U.S.A.

LARGEST of the tilt-wing aircraft now under development in the United States, the X-18 is being built around the fuselage of a Chase YC-122 transport to save time and cost. In concept, it is fairly close to the tilting-rotor type of convertiplane; but in this case the entire wing pivots through 90 degrees, providing a more rigid transmission and enabling the wing to contribute considerable lift during transition from vertical to horizontal flight. Another advantage is that when airfields are available the X-18 will be able to take-off and land horizontally, with an increased payload. The initial contract for the X-18 was placed by the U.S.A.F. in February, 1957, the prototype is now in an advanced stage of construction.

Dimensions, weights and performance data are not available.

(*Continued on page 867*)

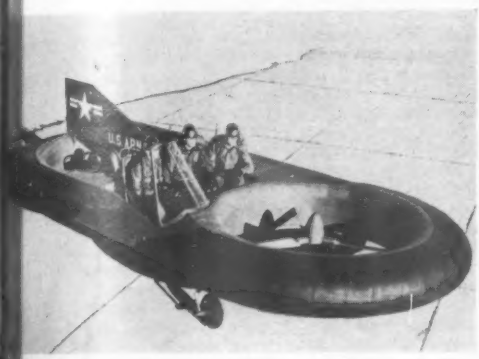
International VTOL Survey . . . .

U.S.A.

HILLER VZ-1E PAWNEE

KNOWN usually as a "flying platform," this aircraft makes use of the principle that a fan contained in a properly-designed duct will produce the same thrust or lift as an unshrouded fan of much greater diameter. The original Hiller prototype, which made its first flight on February 4, 1955, had a duct of only 6 ft. diameter, containing co-axial fans driven by a pair of 42-h.p. Nelson two-stroke engines; but the VZ–1E now under development for the U.S. Army has an 8-ft. duct and a third engine for increased safety. Only control is a twist-grip throttle on the handlebars to control climb and descent. The pilot changes direction of flight by shifting his weight or leaning in the direction in which he wishes to go.

Dimensions, weights and performance data are not available.



PIASECKI VZ-8P (Model 59-K)

U.S.A.

THIS VTOL aircraft is the nearest thing yet to a flying motorcar. It consists in its prototype form of two ducted rotors with a central platform carrying the two 180-b.h.p. Lycoming engines. Three seats are in the centre-body. Normally it will fly close to the ground, but it is claimed to be capable of crossing most mountainous regions in the United States, and will have a forward speed of more than 150 m.p.h. The prototype, which flew for the first time on October 12 this year, was built under contract to the U.S. Army Transportation Research and Engineering Command, as a "flying Jeep" for observation, liaison and weapon carrying; but Piasecki plan to develop a commercial model with powered wheels for ground movement and an enclosed four-seat cabin.

Dimensions, weights and performance data are not available.

RYAN X-13 VERTIJET

U.S.A.

SUCCESSOR to the Lockheed XFV–1 and Convair XFY–1 turboprop "tail-sitter" interceptors of a few years back, which offered inadequate performance potential, the X–13 utilizes the more practical power of a Rolls-Royce Avon turbojet. It has no undercarriage, taking off instead from its mobile servicing and transport trailer, the bed of which can be raised vertically for the purpose. The X–13 is virtually "hooked" on to this bed, and the pilot releases it by simply opening up the engine and taking off by direct jet-lift. Control during vertical and hovering flight is by jet deflection and throttle variation. Conventional flying controls are provided for cruising flight. The first successful transition from vertical take-off to horizontal flight and back to a vertical landing was made on April 11, 1957.

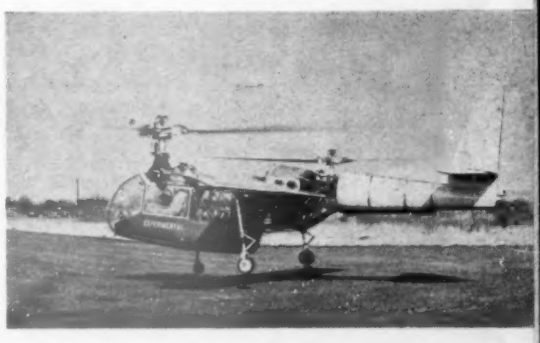
Dimensions (approx.).—Span, 21 ft.; length, 24 ft.; height, 15 ft.
Weight.—Normal take-off, approx. 8,500 lb.
Performance.—Not available.

U.S.A.

TRANSCENDENTAL MODEL 2

UNDER development to U.S.A.F. contract, this tilting-rotor convertiplane is an improved successor to the Transcendental Model 1–G of 1954–55 (illustrated), which achieved a 90% conversion (90% of lift provided by wings, 10% by rotors) before being lost in an accident unconnected with its unique configuration. It is powered by a 250-b.h.p. Lycoming O–435–23 flat-six engine mounted behind the two-seat cabin and driving two fully articulated wing-tip-mounted rotors through spanwise shafts.

Dimensions.—Span, 22 ft. 9 in.; rotor dia., each 18 ft.; length, 22 ft. 1 in.; height, 9 ft. 5 in.
Weights.—Normal take-off, 2,250 lb.; empty, 1,580 lb.
Performance.—Not available.



U.S.A.

VERTOL VZ-2 (Model 76)

FIRST tilt-wing aircraft to fly, the Vertol 76 passed a milestone in VTOL progress on July 23 this year, when it was announced that it had completed successfully transitions from vertical to horizontal flight and *vice versa*. It did this little more than two years after the prototype contract was awarded to Vertol by the Office of Naval Research and the U.S. Army. Of extremely simple design, the Vertol 76 is powered by a single fuselage-mounted Lycoming T53 turbine, driving the two rotor-propellers through shafts. Vertical and horizontal ducted fans in the tail unit provide additional control during vertical and low-speed flight.

Dimensions.—Span, 24 ft. 11 in.; rotor-propeller dia., 9 ft. 6 in.; length, 26 ft. 5 in.
Weights and performance.—Not available.

Everybody's Helicopter

TO the man in the street the helicopter is an aerial car to rise from his roof or his backyard. The popular image of the helicopter is everybody's helicopter. Everybody is still waiting.

At first, the helicopter was young and promising. No one can go on being young and promising for too long. Eventually the helicopter may cease to be either. Searching for reasons to explain the absence of the personal helicopter, we must distinguish between the helicopter as a symbol of vertical flight and the helicopter as a mechanical conception.

The need to take to the air in a flying machine capable of vertical flight has not diminished, it has increased. The promise of the helicopter as a mechanical conception is a subject for controversy. According to your school of thought the promise may be either too early or too late.

Flying gives many satisfactions, including that of being "one-up." Apart from sentiment, the main reason for taking to the air is that we are in it already. For many serious and frivolous purposes we want to advance at a speed of around 100 m.p.h. If so, we face the resistance of the surrounding air; to overcome this resistance (or drag) mechanical power must be expended whether we move on the surface or fly. At 100 m.p.h., the difference is insignificant. So insignificant in fact that, having learnt to fly, one wonders how the whole vast system of roads and other surface amenities can be justified.

Flying by the conventional fixed-wing aircraft is no substitute for road transport. Such flying relies on vast ground facilities and implies a dependence on weather, both of which reduce its utility in short-range conveyance almost to vanishing point. To overcome both shortcomings we need vertical flying, including the ability to hover with confidence. The helicopter as a mechanical conception, roughly in its present form, fulfils these basic requirements. Moreover, it is capable of hovering with no more power than it needs for forward flight at roughly 100 m.p.h.

In this sense the helicopter is ready to fulfil its promise. No other mechanical conception can make such a claim. None is likely to do so within engineering and economic knowledge or vision. However limited, the vision goes far enough to create an industry without fear of obsolescence.

In this framework, the helicopter is understood as a flying machine with mechanical power deriving its lift mainly from a lifting rotor and capable of hovering. Pursuing this specification further, the personal helicopter should carry between two and four people, including the pilot; it should be capable of flying under adverse weather conditions, including zero visibility, icing conditions and in winds up to 50 m.p.h.

The subject of safety needs special emphasis in a flying machine for owners of limited qualifications. Structural safety is taken for granted. In so far as structural safety depends on maintenance, the design of the helicopter must ensure an organization of maintenance adapted to private ownership. Sealed maintenance of major assemblies is an essential condition. Field maintenance and its inspection must be clearly prescribed, simple and devoid of special skill.

It is axiomatic that however good the standard of maintenance, no power unit has ever attained the standard of reliability of an airframe. Our personal helicopter must have at least two engines so rated that completion of flight or return to safety is possible on one engine.

Another feature demanding special attention is the piloting skill required. The personal helicopter should be forgiving in its demands on piloting experience and attention. Among skilled helicopter pilots, stability is often considered the first requirement, especially when associated with blind flying. To the not-so-skilled pilot the primary danger is overspeeding or stalling the rotor through faulty application of pitch control. In the ultimate personal helicopter, both dangers must be reliably excluded.

A flying machine so specified, with an acceptable noise level, would have a utility value so universal as to justify production in quantity. If sold at the present-day price of even a luxury car, a two-seater helicopter with the qualities just stated would have a market several times greater.

This has been verified in a Market Research survey of Canadian prospects carried out some time ago as a thesis at the College of Aeronautics. The reasons are clear. In densely populated areas the helicopter will offer an effective speed of almost twice that of the fast car. In sparsely populated areas it will offer the same speed over roadless country.

In short, the rational view is that we can have greater utility at the same cost when the journey is necessary and speed is justified. The visionary scope is measureless. The prize is the freedom of the air and the price is the same as the upper reaches of motoring.

All this is within our grasp without fundamentally new development. Indeed, it has been within our grasp for some years. This fact is beginning to weigh against the faith in the achievement. We cannot avoid the challenge by the sceptics: if you can do it, why don't you?

Every engineering achievement requires a form of organization of human effort. The organization must be adapted to the task. The task of developing a personal helicopter requires concentration on the job of carrying a human seat such as is practised by motorcar makers. These in turn are not alive to the penalties which the air imposes on design. The personal helicopter requires not only a new development effort but a new kind of framework for the effort.

The atmosphere of technical progress has created the expectation of something fundamentally new at every turn. The search for the miracle formula has prevented the delivery of a miracle by human means. Thus we see a succession of ideas, often not so well "integrated" with bolts and nuts.

Engineering is an art and rests on proportions. Doctrines are the enemies of proportion. Some temperaments find it difficult to abandon doctrines and think in engineering terms. Instead of proportioning, they "compromise."

One of the current dogmas centres around the phrase "integrated lift systems." The word "integrated" is ill chosen and should be replaced by "dual purpose," which signifies that the same system of physical components serves for both sustentation and propulsion. In fact, the pure helicopter is the only truly two-purpose lift system that works.

Another dogma is the belief that pipes are modern and gears are old-fashioned. If based on fact, it is merely the fact that there has been more trouble with gears than with pipes in helicopters, mainly because there are more gears than pipes.

The pursuit of these and other fashions has, in the recent past, been the main cause for diverting effort and finance from the business of sound development of what is primarily a device of mechanical engineering.

The natural development of any engineering device destined for general use is a succession of steps each giving greater utility, justifying greater quantity. Sometimes the ultimate utility of the helicopter is questioned on grounds so fundamental as to cover every form of personal flying machine or other personal conveyance.

The limit for the concentration of small helicopters in the air, in the present state of knowledge, is not set by the helicopter but, under poor visibility conditions, by the means of navigation, approach and traffic control in general. Such means need fundamentally new engineering conceptions and development before the helicopter can reach the million market. There is every reason to believe that the means will be found, provided the effort is made.

On the other hand, the level of utility following from the technical specification proposed earlier may be too big a step to be taken at once. An intermediate step is conceivable when a two-seat utility helicopter, falling short of the requirements of blind flying, automatic stability and unstallability of the rotor, is sold at the price of a luxury car.

Stating this belief that such an initial step is at present the right measure of advance necessary to create a new industry, I leave my task as a surveyor and become a bricklayer.

With the help of some modest sponsorship and a small team of enthusiasts, a helicopter of the class so distinguished has gradually been growing. Much work remains to be done but we hope to face the world in the coming spring.

The reasoning and sentiments of these lines have been the basis for the conception and have guided us in pursuing the new project. In the words of the poet, "He who wrote this knows all the cost."—

J. S. SHAPIRO.

Third R.S.A. Cantor Lecture

Looking into the Future

DELIVERING the third R.S.A. Cantor lecture in London on December 8, Mr. E. C. Mensforth, C.B.E., M.A., M.I.Mech.E., F.R.Ae.S, chairman of Westland Aircraft, Ltd., discussed the "Future of the Aeroplane." His object was to summarize the environment in which development may proceed, the trend of its likely results and the probable controlling factors. A series of extracts from the lecture follow though it has not been possible to make reference to all the aspects covered by the lecturer.

Research

Progress involves long-term pure research and short-term *ad hoc* work; programmes are concerned not only with supporting current designs but with looking a long time ahead. Present results are the basis for a new design concept which, from inception to practical use, may well take 10 years. The whole business is essentially competitive and the time scale is as important as the actual results. There remains great scope for aeronautical research and it is still essential to national survival and industrial prosperity.

Immediate Development

In considering this, a recapitulation of current performance is useful. Subsonic, over 500 m.p.h. aircraft, are in regular operation, e.g., Avro Vulcan bombers, and de Havilland Comet 4 airliners. Over the past 10 years research has raised speeds from 600 m.p.h. to 2,000 m.p.h. with a variety of piloted experimental aircraft. This year the absolute speed record was brought up to 1,407 m.p.h. Earth satellites, travelling at 20,000 m.p.h., have been placed in orbit by the U.S.S.R. and U.S.A., and the latter has shot a moon probe to a height of 79,000 miles.

The new aircraft which will fly or come into service in the next, say, five years were conceived some years ago and their characteristics are already determined. Examples are:—

(a) Military: supersonic fighters around Mach 2, e.g., the English Electric P.1; fast attack, e.g., Blackburn N.A.39.

(b) Research aircraft: e.g., the North American X.15, flying at Mach 5, and 500,000 ft.

(c) Long-range subsonic transports: e.g., Vickers VC10, on order by B.O.A.C., 299,000 lb. gross weight, about 600 m.p.h., 152 passengers, four Rolls-Royce Conway by-pass turbojets, each of about 20,000 lb. thrust.

(d) Medium-range subsonic transports: e.g., the de Havilland DH121, on order by B.E.A., 600 m.p.h., 100 passengers, with three rear-mounted turbojets.

(e) Turboprop short- and medium-range transports: e.g., the Vickers Vanguard, 425 m.p.h., 139 passengers.

(f) Specialized freighters: e.g., Hawker Siddeley Argosy, 296 m.p.h., 27,000 lb. load.

(g) All-weather multi-engine vertical lift aircraft of relatively slow speed, short range, say up to 250 miles: e.g., the Westland Westminster helicopter, or the Fairey Rotodyne, rotary wing compound, both using twin Napier Eland turbines and carrying a load of 5-6 tons, or about 40 passengers, at 150/185 m.p.h.

(h) Missiles of intercontinental range may be expected to be available.

(i) Unmanned space rockets should be regularly reaching escape velocity with small payloads.

Military Aircraft

The vital factor in the future of military aircraft is the development of nuclear explosives—which have increased by over one million times the destructive power of a single bomb—which, being of moderate weight, may be delivered by a vehicle of great speed and range. Some bombers will continue to be manned so that they may patrol to avoid surprise attack and to permit of recall when once they have begun a mission. Ultimate speed, fast, say Mach 2.5, or very fast, e.g., say Mach 10, will depend on political choice within the technical possibilities of balancing fuel consumption against duration.

The development of the intercontinental ballistic missile may be less concerned with fundamental design and more with the task of reducing preparation time for firing, increasing reliability, and avoiding detection.

The terrible fact about any of these vehicles is that a single bomb delivered without any great need for accuracy can do damage which, when multiplied a few times only, may be decisive. An aggressor can accept losses knowing that they need not be repeated if any of his force succeeds in its attack. The burden of defence is enormously increased; it has to be very close to 100% effective or fail. The United Kingdom official policy is to develop no new manned fighters; in the U.S.A. manned fighters of very advanced performance are perhaps fore-shadowed by the research aircraft mentioned earlier. Alternative defence is by the ground-to-air guided weapon; particularly when equipped with a nuclear warhead, such a weapon should be effective? Unfortunately, it must rely on electronic devices which are vulnerable to similar interference, and it is difficult to be optimistic about 100% interception.

There will be a certain need for fast, long-range transport aircraft, capable of transferring troops and equipment from headquarters in their own homeland to any part of the World by routes which offend no intervening susceptibilities or necessitate intermediate hospitality in refuelling.

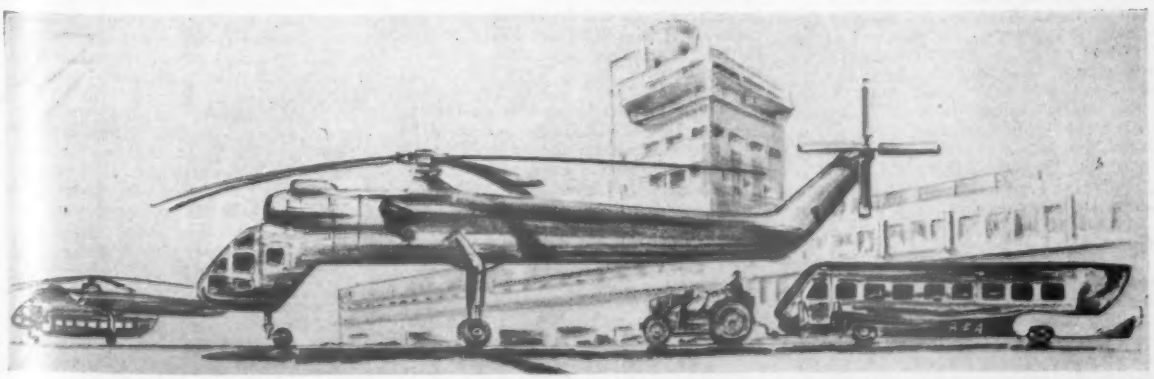
Civil Aviation

Civil aviation basically sells speed. It must not waste a disproportionate amount of time at terminals. It is the overall length of time which matters and by savings here gains may be made as important as those from aerodynamic advances. There may, moreover, be a clash between flying speed and the overall service expected by the passenger.

Supersonic airliners already planned should achieve operating costs comparable with present-day levels. The choice of cruising speed is open: the lowest speed would be 800 m.p.h. (Mach 1.2) when ideally the aircraft would have subsonic flow over the wing, probably over the tail and fin, thus delaying the onset of transonic drag rise.

The next speed would be about 1,200 m.p.h., when an economic cruising performance would be obtained with a very slender wing plan form of aspect ratio unity and sweepback 70°/80°; this would probably take the form of an all-wing aircraft of say 7,000/8,000 sq. ft. area, sufficiently large to contain the passenger accommodation. This configuration brings low-speed problems which we can expect to overcome by novel devices such as jet deflection; variable wing geometry, such as that projected by Dr. Wallis of Vickers may also be relevant.

The next speed would be about 2,000 m.p.h. (Mach 3), where the turbojet engine operates close to its optimum. Such an aircraft introduces entirely new



FIRST-CLASS TRAVEL.—A scheme suggested by Mr. Mensforth using detachable first-class passenger units.

problems of kinetic heating, and consequently of new structure and of new engine layouts. Its development would be a project of great magnitude.

The development of faster aircraft, within the limits of conventional shape and structure, is likely to continue the historical trend in absolute terms of cheaper and cheaper flying. Costs per passenger mile have fallen from (say) 10d. in 1920 with speeds of 50 m.p.h. to 4d. in 1958 with speeds of 400 m.p.h. But it will be prudent to expect a stage at which, at least for an appreciable and expensive development period, the economy of the "faster and higher" philosophy reaches its optimum. Beyond this the desire for speed and very short travel times may have to be paid for: high Mach number flight requires also high altitude.

Higher cruising speeds are even now contemplated. A recent Bristol study is concerned with a powerplant combining turbojets for take-off and landing with ramjets for high-speed cruising. Both are built into the wing thickness and use a common supersonic air intake. A flexible arrangement results, with the possibility of a payload 50% greater than that of a turbojet, when operating at a long range of 3,500 miles and a speed of Mach 3. The U.S.A. Navaho unmanned, winged, nuclear delivery vehicle design study is propelled by 48 in. twin ramjets, with initial launching by rockets of around 400,000-lb. thrust to give a Mach 3 performance at a range of 6,000 miles. The cost was estimated at $620 million, a useful indication of what may be involved in such development.

Still faster travel may be achieved by initial acceleration to a great speed and height and then gliding to the destination—the "boost glide" technique, with flight durations of say one hour for distances of around 10,000 miles. Formidable, but certainly not insuperable, problems arise of accommodating passengers in such circumstances.

Terminal Delays and Short Journeys

It is now accepted that most long journeys will be made by air. Already a majority of people crossing the Atlantic fly. But, even in the U.S.A., of those using public transport services for distances between 100 and 250 miles only 12% go by air; and for distances below 100 miles less than 1% fly. Within a 150 miles radius of the Midlands of England reside nearly 40 million people; within 200 miles of Brussels, over 70 million; their respective surface transport systems are increasingly congested. The distance from London to Paris or Brussels is little more than 200 miles.

There is here a fine potential load for suitable flying machines, but the conventional arrangement, because of long terminal delays, is normally unsuitable. A passenger travelling on a British internal air service may spend three hours from and to the city centre in buses so that, although his aircraft cruises at 350 m.p.h., he may only achieve an average speed of 55 m.p.h. The fastest trains already average 50-60 m.p.h. from city centre to centre, and it would be wise to assume that this may improve to 70-80 m.p.h.

The helicopter offers a more flexible solution, and one cheaper in capital cost if it is assumed that a minority of people are prepared to pay for the fastest possible overall speed of travel. But it is unlikely to compete in cost with surface transport. Capital costs at say £5,000 per passenger can be comparable with those of conventional aircraft, and indeed of Atlantic liners—but they are much higher than a bus at (say) £200. Operating costs of (say) 8d. per passenger mile are in sight and may well fall to half this sum.

Helicopter terminal facilities will be much cheaper than airports; they may be situated on the top of large commercial buildings. A helicopter capable of averaging 125 m.p.h. would save 30 minutes on the above 125-mile journey, and would be faster than aircraft plus monorail up to about 300 miles.

One solution to the problem of terminal delays and the discomfort and frustration of standing and waiting in controlled crowds would be to use a helicopter crane carrying a separate fuselage unit, with conventional seating, which alternatively is fitted with road wheels. First-class passengers would take their seats as they arrived; baggage would be palletized and remain so throughout for rapid lift-truck handling. The whole would fly to the airport where the high-speed aircraft would be waiting, immediately prior to take-off, already loaded conventionally with its lower fare class passengers and freight; the unit would be towed to it, and transfer quickly effected.

At the destination the procedure would be reversed and the first-class passengers accorded that priority and prompt time-saving attention throughout for which they had paid; some ticket and governmental procedure could well take place during the transit time.

Vertical Take-off

The ability to hover, to take off and land vertically and to be independent of extensive terminal facilities, is valuable for many civil tasks, e.g., inter-city transportation; exploration; and for military use, e.g., rescue, rapid troop and equipment movement independently of terrain, and submarine killing.

The helicopter is the most efficient method yet devised of vertical lift, but it is restricted by its geometry to forward flight speeds not exceeding 200 m.p.h. Such a speed, after allowing for average adverse winds, permits of block speeds still sufficient to make it the fastest short-range vehicle, up to say 200-250 miles. Speed is not its only value: its ability to handle loads of any size or shape within its weight limitations will ensure its further development for both military and civil tasks.

Immediate development is typified by the Westland Westminster, powered by twin Napier Eland 3,000-h.p. gas turbines, carrying loads of 5-6 tons, at 150 m.p.h., weight 35,000 lb., rotor diameter 72 ft. The future is analysed by Mr. O. L. L. Fitzwilliams in his paper, "The Giant Helicopter," read to the Helicopter Association of Great Britain in 1951. It concludes—and subsequent work supports this—that with gas turbines situated at the blade tips, there are no insuperable difficulties in developing a helicopter to transport a useful load in excess of 50 tons, 100 miles in one hour; such a machine would have a rotor diameter of 200 ft. and weigh about 205,000 lb.

The speed limit of the helicopter may be overcome by various types of convertiplane. The Fairey Rotodyne, now under flight development, combines a rotary and conventional wing, the latter unloading the former in forward flight to give a cruising speed of 185 m.p.h. The Bell experimental machine has rotors on wings swivelling about a longitudinal axis to bring them from the vertical lift configuration into the forward flight one. Convertiplanes suffer from the inherent disadvantage of having to carry, during two flight phases, the deadweight of the equipment for the other: optimization as between lift and speed remains a compromise.

An alternative approach is to utilize direct turbojet thrust for lift, as in the experimental Short S.C.1. This is likely to incur disadvantages from the points of view of economy and noise, so far as civil aircraft are concerned, but it has military possibilities.

The personal or family helicopter naturally excites the imagination. The havoc wrought by the automobile, with its simple single degree of freedom, is a warning that the man in the street is likely to remain insufficiently trained and disciplined to handle a flying machine until the control of this is completely automatic in respect of routeing and avoidance of collision. This may become possible with the development of light, compact, automatic control systems.

Cost would be greatly reduced by volume production, as there is nothing inherently difficult or expensive in making the conventional helicopter other than the necessity for using first-class materials, workmanship and inspection. The "personal flying platform," a ducted fan, is already coming into military use and may indicate one line of development.

Sporting and Private Flight

With increasing air congestion and the need for a high standard of control, sporting and private flying seems likely to meet even more difficulties. But cheaper and lighter instrumentation may offset this and, in particular, enable sporting flight to increase in the gliding and ultra-light fields. One of man's oldest dreams now appears to be possible, that of man-powered flight. This is analysed by Mr. T. R. F. Nonweiler in a paper in the 1958 proceedings of the Royal Aeronautical Society.

Space Travel

Flying has until now been an alternative to surface transport; for space travel it is the only possibility. A rocket capable of carrying a man into space will certainly be developed, as will guidance systems to enable it to reach any desired destination. There are many hazards, some obvious, some as yet unknown and unsuspected. The problems of providing an environment in which the passenger can survive are so formidable as, in the foreseeable future, to rule out the rocket as a means of travelling from one part of the World to another; the relatively small reduction in transit time would be unlikely to justify the cost.

Man is certain to want to travel into outer space for adventure and because, with his capacity for reasoning, he will be a better instrument of exploration than a machine. Provided with a hermetically sealed cabin he can survive. This cabin has to be maintained as closely as possible to terrestrial conditions, so that with the long periods involved and the great tasks to be performed, there should be the minimum of deterioration from optimum human standards.

Protection has to be given against acceleration, acoustic energy effects, weightlessness, temperature, radiation, and meteorites, and in some way cramped space, boredom, etc., have to be minimized. Great as the problems are, it is possible to foresee their solution; but immense resources and much expenditure of time and effort will be required.

Flying Training Command

AIR MARSHAL SIR HUGH A. CONSTANTINE, K.B.E., C.B., D.S.O., has been appointed Air Officer Commanding-in-Chief of Flying Training Command with effect from March 1, 1959, in succession to Air Marshal Sir Richard Atcherley, K.B.E., C.B., A.F.C., who is retiring from the Service. At present Deputy Chief of Staff, Plans and Policy, SHAPE, Air Marshal Sir Hugh Constantine was previously A.O.C., No. 25 Group, Flying Training Command.

A French Supersonic Bomber

DEVELOPMENT of a supersonic bomber—the Mirage IV—to carry the French atomic bomb, which is to be tested for the first time early in 1959 in Southern Algeria, is reported to have been given high priority in France. The decision to build up a strategic bomber force, with all its financial and political implications, will raise France's military stature to the level of Britain, the U.S. and the U.S.S.R., and the Mirage IV is being designed with a very high performance at low levels capable of reaching strategic targets in Russia.

Although nominally a continuation of the Mirage series of interceptors, of which the Series III is to be the main French fighter, the Mirage IV is apparently a completely new design of delta-wing layout, initially powered by two afterburning Atar 9 turbojets. A truly supersonic engine will later be required for the Mirage IV, which will be built in relatively small numbers.

Scimitar Accident Findings

IT was stated by the Admiralty last week that the Scimitar accident on H.M.S. "Victorious" on September 25 was caused by a small valve being inadvertently left open when the arrester system was charged with hydraulic fluid during the carrier's refit. In the accident the C.O. of No. 803 Squadron, Cdr. J. D. Russell, was killed when an arrester wire broke following a landing-on and his Scimitar crashed over the side.

At the inquest it was stated that the Scimitar touched down on the flight deck correctly and its hook engaged the first arrester wire. This partially decelerated the Scimitar and then the wire broke. The Scimitar continued along the angled deck and went over the edge, its speed at this point being a fast walking pace. Lieut. Cdr. C. Parker of the Admiralty Investigation Unit, who gave formal evidence, said that there was no question of sabotage of the arrester gear. Cdr. Russell was unable to get out of the cockpit because of a chain of circumstances, all contributory.

First, he tried to jettison the hood, but had difficulty in operating the release handle, which constituted a time waster while he sorted out the alternative means of getting the hood open. Secondly, he had difficulty with his oxygen equipment, breathing a mixture of oxygen and water, and would have wasted further time taking off his helmet and oxygen mask. Cdr. Russell tried to open his hood manually and partially succeeded, but it closed again. He opened it after the aircraft had submerged but at that point was trapped in the cockpit by the ejection-seat leg restraint and also by the lanyard connection between his life-jacket and his dinghy. The quick-release mechanism had not been disconnected.

Scientific Education Interchange

TO improve and increase the interchange of ideas between scientists in the United Kingdom and on the Continent, the CIBA Fellowship Trust has been formed with Sir Arthur Vere Harvey, C.B.E., M.P., Lord Hives, C.H., and Professor Sir Alexander R. Todd, F.R.S., as trustees.

Several Fellowships are to be awarded for tenure during the academic year 1959-60 at Continental universities or institutions for research in chemistry, physics or some other allied scientific subject. They will be available to graduates of universities in Great Britain and Eire, or to members of those universities graduating this year; some Fellowships may be awarded to recent graduates and to candidates who have already taken their Ph.D., or who have already spent some time in industry.

The basic award for Fellows who have already undergone training in research and wish to continue post-doctorate studies will be £800 a year, plus allowances. Candidates who have obtained a first degree in science, and who wish to undergo training in research will receive £500 a year, again with allowances.

The advisory panel is composed of:

Sir Arthur Vere Harvey (chairman); Prof. A. J. Birch (Manchester University); Prof. W. Bradley (Leeds University); Dr. A. Brunner (CIBA, Ltd., Basle); Dr. E. Brunner (Clayton Aniline Co., Ltd., Manchester); Prof. D. H. Everett (Bristol University); Prof. D. M. Newitt (London University), and Dr. R. F. Webb (CIBA (A.R.L.), Ltd., Duxford).

Readers who want more information should write to the secretary of the CIBA Fellowship Trust, CIBA (A.R.L.), Ltd., Duxford, Cambridgeshire.

Polar Pioneers

SIR HUBERT WILKINS, M.C., who died in Massachusetts on December 1, will for ever be associated with aircraft in both Arctic and Antarctic exploration, ranking with Amundsen, Nobile and Byrd.

Born in Australia on October 31, 1888, he learnt to fly well before the First World War and was commissioned in the Australian Flying Corps in 1917. He was early taken with the idea of flying over the Arctic Ocean, but it was not until 1926 that he was able to take an aeroplane to the Arctic; his plan to fly from Spitzbergen to Alaska in 1919 was regarded as fantastic and no sponsors were forthcoming. In 1919, as Capt. G. H. Wilkins, he was navigator on a Blackburn Kangaroo entered for the England—Australia flight competition, but the flight had to be abandoned after crossing the Mediterranean.

At Point Barrow, Alaska, in 1926, with Capt. C. B. Eielson as pilot, Wilkins flew over about 100 miles of pack ice, but his intention of flying to Spitzbergen proved impracticable. Disappointment did not deter him from further polar plans, and he continued to make various flight trials in a three-engined aeroplane. In one of them, in 1927, he made a forced alighting on pack ice in a blizzard, 550 miles from Point Barrow. Wilkins and Eielson walked 100 miles in 14 days before reaching a settlement.

After this Wilkins acquired a Lockheed Vega, and on April 16, 1928, again with Eielson, took off from Point Barrow for a non-stop flight to Spitzbergen. After flying for 20 hr. 20 min. they were forced down on the ice by bad weather only a little way from their destination. They were unable to resume the flight for a week, but finally arrived safely. Shortly afterwards Wilkins was knighted, and was honoured by the R.G.S.

Sir Hubert next turned his attention to the Antarctic and, with three others, including Eielson, set off in December, 1928, from Deception Island and made a flight to 72° S. and back, 1,200 miles in all. They proved that Graham Land was not, as had been supposed, a peninsula but two islands. A second visit to Antarctica was made early in 1929 and Wilkins reached longitude 101° in latitude 73°.

Wilkins' first polar experience had been with Stefansson's Canadian Arctic Expedition in 1913, and throughout his life he was devoted to polar conquest. He proposed an under-the-ice expedition to the North Pole in 1931, an ambitious project abandoned only after defects in the submarine "Nautilus" prevented his getting farther north than 82° 15'. From 1942 to 1952 he was a consultant to the U.S. Army Military Planning Division, and since 1953 had been geographer to the Research and Development Command, U.S. Department of Defense. He continued to fly in polar regions.

Wilkins' death has occurred only a few weeks after that of another Australian polar pioneer, Sir Douglas Mawson, who died in Adelaide on October 14, aged 76. Although not associated to any great extent with polar flying, as early as 1911 Sir Douglas wanted an aeroplane for his Antarctic expedition. He approached the Vickers company and was sold the very first Vickers aeroplane, an R.E.P. monoplane, which was shipped to Australia, though its usefulness was obviously limited.

From the Lecture Room

Ramjets for Supersonic Airliners

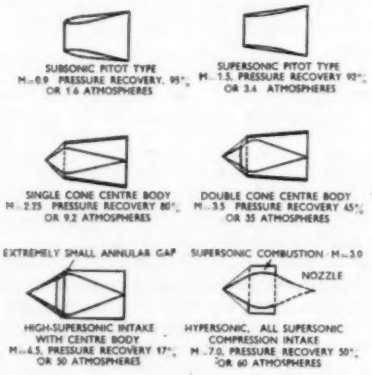
DR. R. R. JAMISON, chief ramjet engineer of Bristol Aero-Engines, Ltd., emphasized the advantages of ramjets for supersonic airliners in a recent lecture before the Bristol Branch of the Royal Aeronautical Society. After discussing the applications of ramjet power for propulsion at speeds up to Mach 5, he went on to consider the types of ramjet which might be suitable for hypersonic flight up to Mach 12.

Ramjet Efficiency

At speeds above Mach 2 the compression ratios produced in a ramjet intake are as great as or greater than those used in high-economy turbojets. These compression ratios are 6 at M=2, 15 at M=2.6, 27 at M=3, 65 at M=4 and 100 at M=5. Such high values indicate that excellent operating-cycle efficiencies should be achieved.

The ramjet engine is more efficient than the turbojet on a thermodynamic basis at speeds above Mach 2. Weight is an important factor and when this is also considered the turbojet shows up even worse at high speeds.

Other disadvantages of the turbojet at high speeds are its susceptibility to intake buzz and the fact that airflow through it decreases on throttling down, while the reverse applies with the ramjet. A variable-geometry intake is essential for

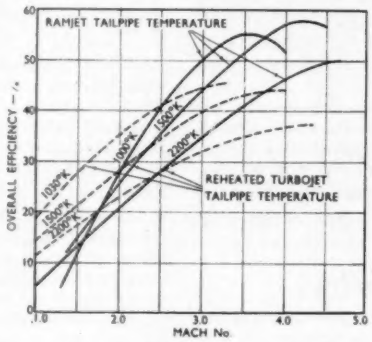


Typical intake configurations and performance for ramjets operating up to Mach 7.

a high-speed turbojet unless severe performance penalties are to be accepted, but it is a refinement for a ramjet.

The superiority of the ramjet for flight speeds greater than Mach 2.5 led to Bristol studies of the use of ramjets for supersonic transports. Range is the great criterion; the Breguet formula gives range as $R = C \cdot \frac{V}{s.f.c.} \cdot \frac{L}{D} \cdot \log \frac{W_1}{W_2}$ (where C is a constant, V is airspeed, s.f.c. is specific fuel consumption, L/D is lift-to-drag ratio and W_1 and W_2 are initial and final weights of the aircraft).

The formula suggests the dominant effect of speed in contributing to range, and in fact the term $\frac{V}{s.f.c.}$ expressed in consistent units gives the overall propulsion efficiency. The graph below shows this efficiency plotted against Mach

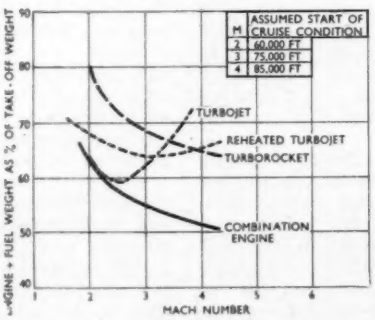


Propulsion efficiency at supersonic speeds for ramjet and reheated turbojet engines.

number for ramjets and reheated turbojets. Efficiency rises with speed, showing that if L/D ratio can be kept to a reasonable value the very fast aircraft should have a good range and payload.

A practical transport must have power for take-off and low-speed flight as well as for high-speed cruise, and thus ramjet power alone is not suitable. Because of this, comparative Bristol studies have been made of four engine types. These are the turbojet, reheated turbojet, combined ramjet and turbojet, and the turborocket, which involves use of the ramjet. A graph on this page shows the combined engine plus fuel weight for these powerplants if used in a Mach-3 airliner with a 4,000-n.m. range.

These studies indicate that a long-range supersonic transport could be produced with useful range and payload characteristics. Speeds around Mach 3 (1,760 knots) appear to offer a reasonable engine performance on a thermo-



Engine + fuel weights for a supersonic aircraft with a cruise range of 4,000 n.m. and a L/D ratio of 7.5. Advantages of the combination engine which integrates ramjets and turbojets are evident.

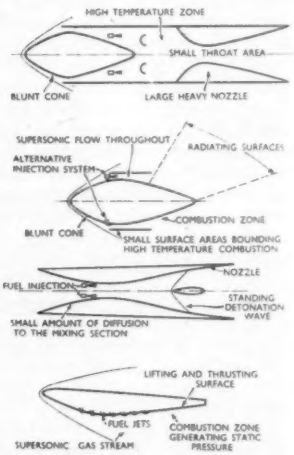
dynamic basis to match the likely airframe characteristics, and ramjets with their high efficiency and low weight offer the best cruise powerplant. Economic long-range flight at Mach 4 can be envisaged by evolution along current engineering lines without using materials or techniques unknown today.

Hypersonic Developments

The hypersonic régime above Mach 5 introduces new factors which affect the design of air-breathing engines. Intake-area ratios become so large that a new design approach is necessary. High ram temperatures bring changes in gas properties caused first by dissociation and then by ionization. Difficulties arise in adding of heat to gas which is already at high temperature. The problems of cooling and structures become much more difficult and tax our knowledge of materials and heat-transfer techniques.

How will hypersonic engines look and what will their performance be? Not much information is available and the answers must be largely speculative. But the engine will still depend on the compression, heating and expansion cycle.

The diagram in column one shows the trend of intake configurations. At Mach 4.5 a better pressure recovery could be expected from an isentropic spike, but the intake annulus would be smaller still and have increased sensitivity to adverse conditions such as yaw. At Mach 7 the



These types of hypersonic ramjet are described in the text. Reading downwards, they are an orthodox arrangement, a ramjet with supersonic combustion, a ramjet with supersonic combustion with a detonation wave, and an external ramjet.

area ratio for no losses is about 30 : 1, and thus the all-supersonic ramjet must be considered.

With hydrocarbon fuel and a realistic intake performance the efficiency of ramjets increases up to Mach 7 and useful thrust can be expected up to Mach 10. These figures could be extended by the use of high-energy fuels. Current knowledge indicates that Mach 10 to 12 is the limit with chemical fuels. Peak efficiencies at Mach 7 to 8 with high-energy or hydrogen fuels are around 60% or more, so that long ranges should be achieved with an airframe having a reasonable L/D ratio.

Four possible types of hypersonic ramjet are illustrated on this page. The first

(*Continued on page* 873)

(*Continued from page* 872)

is an orthodox design, the second has supersonic combustion, the third has supersonic combustion with a detonation wave and the fourth is an external ramjet.

Advantages of the orthodox type are that its configuration is familiar and known, and that a large Mach-number range is possible if variable geometry, and the weight penalty it involves, is acceptable. Drawbacks are its weight, which follows from high internal pressure and the need for thick walls and a heavy nozzle. High intake efficiency cannot be used because of the matching problem, and nozzle losses are large resulting in poorer fuel consumption. It is difficult to cool the nozzle and intake surfaces of such a ramjet.

The second type, with supersonic combustion, is light and easier to cool, because of lower peak temperatures and large radiating surfaces. It offers high thrust and low specific fuel consumption when using components at maximum efficiency. Its disadvantage is that an extended boost stage is probably needed to accelerate the vehicle to hypersonic speed.

The third ramjet depends on supersonic combustion with a detonation wave. It again offers high thrust and low fuel consumption. The intake flow temperature is lower because the airflow is always supersonic. The combustion core is only an inch or so thick and combustion intensity is very high. Drawbacks are that the engine is long, that cooling may be difficult on its inner combustion surfaces and that it may not be easy to inject fuel into the airstream without its forming shock waves or burning before reaching the combustor.

The fourth type, the external ramjet, is simple and involves no separate engine. It depends on supersonic combustion and generates lift and thrust together. Disadvantages are the considerable development work needed to obtain efficient combustion and that its thrust may be rather low. But it does appear that an aircraft using external ramjets is likely to have a good L/D ratio and could well be a more efficient long-range load carrier than either the ballistic rocket or the boost-glide vehicle.

(*Continued from page* 843)

NEWCASTLE LIGHTING.—The new G.E.C. approach lighting system has now been installed at Newcastle airport and is one of the first improvements in a series of planned developments at the airport.

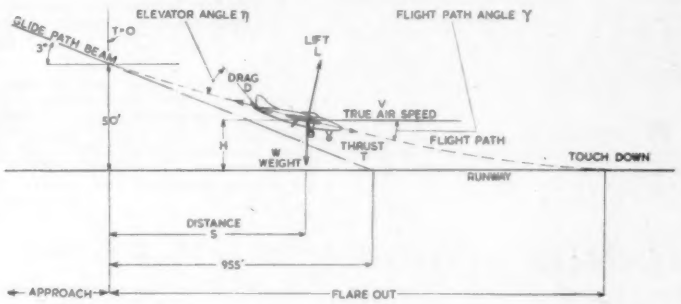
NORTHWEST DEAL. — Northwest Airlines' contract with Douglas Aircraft for five DC-8s at $5,780,000 each specifies the trade-in of five DC-7s at $1,350,000 each. Lockheed will sell 10 Electras to Northwest for $2,400,000 each and will accept nine Stratocruisers for $390,000 each as part of the deal.

D.O.T. VISCOUNT.—The second Viscount for the Canadian Department of Transport left Wisley on delivery on November 22. It was purchased by the D.O.T. in April, and since then has been furnished to V.I.P. standard at Vickers' Hurn factory. Originally built as a V.745 to Capital Airlines specification it is now known as the V.797. The first D.O.T. Viscount 737 flew for 2,668 hours between March, 1955, and November, 1958.

AMERICAN JET PLANS.—American Airlines plan to inaugurate America's first trans-continental jet service on January 25 with a daily non-stop service by Boeing 707-120 between New York and Los Angeles. Frequency will be doubled on February 1. Electra service between New York and Chicago is scheduled to begin on January 23 with six non-stop flights each day. The American 707 will seat 112 passengers divided equally between first-class and coach class; the Electras will seat 68 first-class passengers. These plans are subject to a satisfactory conclusion of present negotiations with A.L.P.A. and F.E.I.A.

AIR REGISTRATION BOARD.—The A.R.B. has issued a new series of Civil Aircraft Inspection leaflets. These are dated December 1 and include two first issues in the "Fundamentals of Inspection" and "General Workshop Processes" basic sections.

Automatic-landing Study



AMONG the demonstrations at the recent Electronic Computer Exhibition was an investigation of automatic-landing technique for jet aircraft. It was made by an F.I.M.A.C. analogue computer on the Elliott Automation stand.

The Aviation Division of Elliott Brothers is studying automatic-landing techniques for high-speed jet transports, and is investigating the control of elevator deflection and engine thrust by an automatic pilot to give satisfactory touch-down. The problem uses 60% of the available computer capacity; the diagram shows the variables. Later investigations with the computer will allow for the effect of wind gradients near the ground.

Military Aviation Affairs

FIGHTER COMMAND.—Air Cdre. E. L. Colbeck-Welch, Commandant of the Central Fighter Establishment, R.A.F. West Raynham, since 1956, has become Senior Air Staff Officer at Headquarters, No. 13 Group, Fighter Command.

R.A.F. BURTONWOOD. — The U.S.A.F. activities at R.A.F. Burtonwood are to be terminated and the base returned to the Air Ministry in the latter part of 1959. The MATS terminal now at Burtonwood will be transferred to R.A.F. Mildenhall, and the 53rd Weather Recon. Sqn. will be moved to R.A.F. Alconbury.

R.A.F. GROUND DEFENCE.—Air Cdre. J. H. Harris is to become Commandant-General of the R.A.F. Regiment with the acting rank of Air Vice-Marshal, as from March 1, 1959, in succession to Air Vice-Marshal J. L. E. Fuller-Good, who is retiring from the R.A.F. Air Cdre. Harris is the first R.A.F. Regiment officer to be appointed Commandant-General. Gp. Capt. K. W. Godfrey has been appointed Director of Ground Defence at the Air Ministry, with the acting rank of Air Commodore.

H.M.S. "EAGLE." — The carrier "Eagle" returned to Portsmouth on December 3 at the end of a 16-month commission. During this time the carrier has been to the Arctic Circle, to the Eastern Mediterranean and into the Black Sea for a visit to Istanbul.

SCIMITARS FLYING.—The order grounding Fleet Air Arm Scimitars, imposed after the fatal accident at R.N.A.S. Lossiemouth on Nov. 19, was lifted last week. This No. 803 Sqn. Scimitar from H.M.S. "Victorious" is seen landing at R.N.A.S. Hal Far, Malta.

Private Flying

H.J.C.'s CLUB COMMENTARY

● A PRIZE of £10 will be paid for a suggestion for a motto which is adopted by the **Association of British Aero Clubs and Centres.** Members of, and others connected with, A.B.A.C.-affiliated clubs are invited to submit suggestions, which should be brief and have a bearing on the aims of the Association. Ideas should be addressed to the Association at 7c Lower Belgrave Street, London, S.W.1. The closing date is December 30.

● ON EXHIBITION at Kennards' store in Croydon is a Rollason-built Turbulent, which has been specially built as a demonstrator for the **Popular Flying Association.** The P.F.A. is to show this aircraft at other stores throughout the country.

The Association's newsletter on this subject says that "for the first time probably in history, members of the public can walk into a shop, climb into a full-sized aeroplane for the modest sum of 6d. and play at flying to their heart's content." But we have an idea that Selfridges had a Gipsy Moth in their aviation department round about 1930, along with a model aeroplane mounted in a wind-tunnel, the attitude of which could be controlled by a joystick and rudder bar. Selfridges, in fact, sold quite a lot of aeroplanes "over the counter."

● LITTLE SNORING aerodrome, about five miles north-east of Fakenham, Suffolk, is the home of the **Fakenham Flying Group.**

EX-AUXILIARIES—Members of No. 600 Squadron Flying Club at Croydon. Left to right, Geoffrey Gostick, Victor Benson, Geoffrey Thomas, Ken Rutter, Roger Marriott, Fred Mussard, and Leslie Mills. Tiger Moths are operated.

This club has 70 full members and about 40 associates. Two Tiger Moths, G-ANFO and AOIP, are operated, and members also have the use of a Proctor joint-owned by three members. About 1,000 hr. have been flown this year. Flying rates on the Tigers are 33s. an hour dual and solo.

The honorary secretary is Denis Kirkham, and instruction is the responsibility of Flt. Lt. "Danny" Kaye from R.A.F. Debden. The suggestion has been made that next year's P.F.A. Rally could be held at Little Snoring aerodrome; it would appear to be a convenient site.

Gliding Notes

by Dr. A. E. Slater

ALTHOUGH the Air Ministry has accepted a tender for Perranporth aerodrome which will allow the Cornish Gliding (and Flying) Club to settle there permanently (THE AEROPLANE, December 5), the country's largest gliding centre at Lasham has still got no security of tenure. Thus, the Cornish Club is adding two substantial and expensive new doors to its hangar, knowing that they will remain its property; but if Lasham were to spend several thousand pounds rebuilding the hangar roof there the Air Ministry could sell it later to a commercial firm for a handsome sum as a waterproof storehouse.

As it is, the roof is so far from waterproof that one can see the holes in it from the entrance to the airfield, and nearly all the fleet, club-owned and private, has to be kept in trailers and re-rigged as required. However, this has not prevented the club making 22,000 launches in the first 10 months of this year for 3,700 hours' flying. Auto-launches and aero-tows were going strong when I called on November 30. David Ince was manipulating lead weights to test extreme C.G. positions in the Olympia 419; this machine, which went to Poland for the World Championships, is now about to pass into private ownership.

When the thermal season is over, it is usually worth looking for waves, even over a flat site. The aero-tows this day encountered suspicious signs, and, sure enough, Peggy Lane found something very like wave lift after a tow to the top of the haze layer at 3,000 ft. It was not quite strong enough for maintaining height in her Skylark 3; but she noticed, away to the north, just above the haze top, some well-developed wave clouds in the direction of the Chilterns. However, according to later inquiry, there was too much murk at Dunstable for any of these wave clouds to be seen, let alone used.

With a light wind from the N.E., Lasham would not have been in the lee of any high ground. Nevertheless, waves of the soarable kind, with wave-lengths of a few miles, can build up over large areas of the Earth's surface independently of any hills. John Neilan, in September, 1945, saw an unbroken series of strato-cumulus waves stretching right across the Irish Sea, and in March, 1950, A. A. J. Sanders flew above a similar unbroken series all the way from Northern Ireland to Kent.

Wind-shear alone can set up waves, as is shown by the "cobblestone turbulence" encountered at the edge of jet streams, and also at lower altitudes, on occasion, by glider pilots flying in waves, although in these cases the wave-length is measured only in tens of yards.

* * *

The T-21 (Sedbergh) built by boys of Leighton Park School, Reading, under John Simpson's direction, is now flying regularly at Lasham, which shares the use of it. The boys, and two masters, assembled the fuselage from the kit of parts supplied in 631 man-hours, the tailplane and elevator in 115 hr. and the rudder in 60 hr. In Slingsby's factory these assemblages are done in 120, 26 and 11 man-hours respectively, while he takes 240 hr. over the wings. The Leighton Park boys obtained the wing framework ready-made, but covering and doping alone took them 243 hr.; however, they did this work so well that the machine is claimed by Simpson to be "the only laminar-flow T-21 in existence." Total hours put in by the school were 1,049, spread over 18 months.

Lasham has its Christmas party on Saturday, December 20, with dancing and a short cabaret. Fancy dress, if worn, should have an aeronautical flavour.

* * *

M. CHARLES FAUVEL has produced an improved version of his famous AV-36 flying wing, which he at first called "Super AV-36" or "AV-361" but has now decided to designate "AV-36 Mk. II." He has increased the wing area slightly and the aspect ratio rather more, giving a span of 12.80 m. (42 ft.), making the best gliding angle 1 in 26 and the minimum sink 0.74 m. (2 ft. 5 in.)/sec.

Other changes are: more powerful brakes of the type used in the two-seat AV-22, directional control increased by 25%, a blown canopy giving plenty of room and "panoramic" visibility, and ovoid fuselage enlarged by 7 cm. at the position of the elbows.

The first prototype AV-22 has now had incorporated the improvements made in the second, and can roll from 45° bank to 45° opposite bank in 3½ sec.

* * *

A SWANSEA gliding club has been formed with 50 members. A gliding section is proposed for Tube Investments, Ltd., at Oldbury in the "Black Country" of South Staffordshire. At Hendon the Air Ministry is planning to start an A.T.C. Gliding School. At Jever, in North Germany, a two-nation gliding club is being formed, the R.A.F. contributing its airfield and the Germans a number of gliders. But—

Wiltshire County Council has opposed an application by the Moonrakers' Gliding and Soaring Club, R.A.F. Upavon, to use land in the Westbury White Horse area as an occasional soaring site. They say it would "prejudice the public right of access" and "become a source of danger." They should take a look at the hundreds of people who sit on Dunstable Downs in the summer.

Correspondence

No Crash When the Camera Stalls

IN your column "Wroundabout" (October 17 last) page 599, you published an inquiry of your reader Mr. L. F. E. Coombs about what happens to the TV camera of the Douglas DC-8 simulator when the operator precipitates a stall manœuvre.

For his information and that of others who may have been intrigued by the question: the Douglas DC-8 simulator will reproduce a stall manœuvre to scale. If the aircraft is high enough and the stall promptly counteracted, the simulator will go through a realistic recovery. If the stall is deliberately made in such a manner that it would lead to a crash, the descent is realistically simulated down to an eye altitude of 15 ft. above the ground. There the motion suddenly stops and a red light goes on at the bottom of the instrument panel. The optics are protected; they do not make physical contact with the map structure, though the clearance is small.

Santa Monica, Calif., U.S.A. IVAR L. SHOGRAN
(Chief Project Engineer, DC-8).

"Flying Can-openers" Again

MAY I point out that "Sixman" (THE AEROPLANE, November 21) is wrong when he thinks that No. 6 Squadron's first post-War aircraft to carry the "Flying Can-opener" device was the Venom?

In 1948 they (No. 6) were based at Khartoum in concert with No. 213 Squadron, both units being equipped with Tempest Mk. 6 aircraft. No. 6 Squadron's Tempests certainly carried the device then, and unless my memory plays me false the insignia was painted on each side of the radiator fairing.

They were still using their wartime squadron code letters as well—namely JV.

I have a photograph of a Harvard bearing the above code letters that was used as a hack by No. 6. If your correspondent "Sixman" would care for this he may have same on application.

They left us toward the end of 1948 and flew, with the 213 boys, to Deversoir in the Canal Zone.

No. 1 Anson Road, R. A. DICKERSON, Cpl., R.A.F.
R.A.F. Benson, Oxfordshire.

Squadron History

WE on No. 14 Squadron wish to improve our picture gallery of photographs of aircraft which have actually flown with the squadron during its history.

May I, therefore, appeal to you and your readers to send me any such photographs, which will be returned subsequently if required?

The squadron will also welcome any correspondence from ex-members who may wish to know something of our present-day activities.

K. E. RICHARDSON, Sqn. Ldr.,
Officer Commanding, No. 14 Squadron.
R.A.F. Gutersloh, B.F.P.O. 39.

Club Relics

A FRIEND of mine has asked me to inquire through your magazine if any of your readers can throw light on two nameplates as depicted here:—

"Surrey Flying Services, Ltd.,
Croydon Aerodrome,
British — G-ABBJ."

"G-AAPH
Herts & Essex Aero Club,
Broxbourne Aerodrome,
Nazeing, Essex."

They were found at R.A.F. Station Chessington in 1945 attached to the fuselage of what is believed to have been a D.H.60. which formed the basis of a dummy Hurricane.

Ocean Vista, J. B. LINDRIDGE.
Cooee,
Tasmania.

[At the beginning of the Second World War many civil aircraft were impressed into service with the R.A.F., either for flying or ground instruction purposes. It would appear that G-ABBJ and G-AAPH, both of which were D.H. Gipsy I Moths, were among them. The former was used by Surrey Flying Services for flying instruction, and the other by the Herts and Essex Aero Club, which a few years ago moved from Broxbourne to Stapleford Tawney. The odd thing is that both identification plates were found on the one aircraft. Perhaps some readers may know more about them.—ED.]

Hawker Hind Conversion

I AM wondering whether it would be possible to purchase a two-seater aircraft rather like a Hawker Hind to convert for private use in this country, always assuming of course that I could get a C. of A. for it.

It would also be a most valuable and interesting experience reconditioning it and getting it into flying condition.

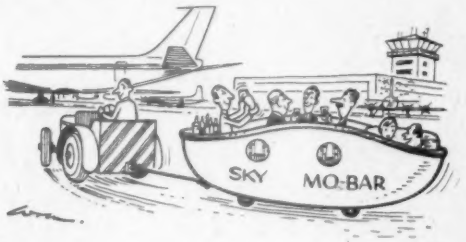
I would be most grateful for the views of other readers as to the possibility of doing something like this.

London, W.4. C. J. M. CARRINGTON.

[We shudder to think of what a Hind, or similar type, even if one were available for civil use, would cost a private owner. The Hind, produced in 1935 as a two-seat day-bomber, had a 640 h.p. Rolls-Royce Kestrel V 12-cylinder engine and weighed 5,298 lb. loaded.—ED.]

Wroundabout

No Omenclature. "AER LINGUS GETS FIRST FIENDSHIPS" says an agency report, showing how careful you have to be when choosing a name. A good name has considerable commercial value, especially if it is capable of being twisted in a friendly way. Remember how Boeing's Stratocruiser on the Atlantic run was called the Stratoboozer because of its well-stocked downstairs bar? People are always telling me how sad they are at the passing of the two-storey airliner with its flying-boat affinities so perhaps Microcell or somebody might design a detachable Speedbar for B.O.A.C. and Stratobar for PanAm and so provide a couple of attractive names.



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On Instruments. A certain airliner captain has a habit, when going aboard and passing through the flight deck, of lightly banging with the flat of his hands on the instrument panels on each side, rather as one taps a barometer with some vague idea of unsticking a sticky needle. A new stewardess, observing this unusual progress, asked the first officer why the captain behaved thusly. "Don't you know?" replied the F.O., "He's as blind as a bat."

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Hollow Laugh Dept. "The influence of air travel can be felt everywhere in the emphasis on *fun*, rather than on getting there."—*The Observer* describing a new British passenger ship.

*

Sign Design. Our motoring organizations will need to add a Missile Recognition page to the German sections of their Foreign Touring Guides. In the meantime, I can tell you that where you see this road sign you are likely to come across a Matador assembly depôt and maybe one of those missiles coming out on a large American truck. I wonder if the Russians are as obliging as this?

by Lorenz

NOTES AND EVENTS

CONTINUOUS TEST.—The second production D.H. Comet 4 began water-tank tests at Hatfield towards the end of June and has now completed the equivalent of 76,000 hours' flying—more than 25 years of normal commercial operations. No failures or cracks have occurred with the application of flying loads.

GLOSTER TURBINES.—The turbine division of the Brush Electrical Engineering Co., Ltd., Loughborough, is to be transferred to a new turbine works being established in part of the Gloster Aircraft Co. factory at Gloucester. Both companies are members of the Hawker Siddeley Group.

DYNAMICS COURSE. — Beginning on January 6, 1959, a course of 24 lectures on "Advanced Aero- and Gas-Dynamics," will be held on Tuesdays (18.45 hrs.) by the aeronautical engineering department of the Northampton College of Advanced Technology, St. John Street, London, E.C.1. The lecturer is Mr. G. A. Tokaty, D.Eng.(Mech.), Doc.Ae.Eng., Can.Tech.Sc., formerly Professor of the Moscow Engineering Institute. Prospective students should have a knowledge of aerodynamics to university degree or good higher national certificate level. The fee for the course is £4 4s.

Company Notices

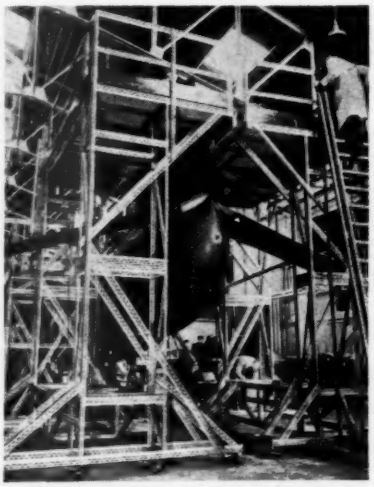
NEW COMPANIES

Airways and General Travel, Ltd. (615,373).—Private co. Reg. Nov. 21. Cap. £100 in £1 shs. Objects: To carry on business as an air transport undertaking and as carriers of passengers and goods by land, sea and air, etc. Directors: Robert J. Lytton, 5 Albert Hall Mansions, London, S.W.7. Roy A. Baldwin, 488 Prince Av., Westcliff, Essex, directors of Airways and General Transports, Ltd. Sec.: R. J. H. Eagle. Reg. off.: 13 Coopers Row, London, E.C.3.

M.L. Engineering Co., Ltd. (615,167).—Private co. Reg. Nov. 19. Cap. £150,000 in £1 shs. Objects: To acquire the greater part of the business, undertaking and assets of M.L. Holdings, Ltd. To manufacture, buy, sell, repair and deal in aerial conveyances, aircraft, armaments, motor cars and mechanically propelled vehicles of all kinds, etc. Subscribers (each with one sh.): F. Thompson, solicitor's clerk, M. J. Ordish, solicitor, both of 11 Old Jewry, London, E.C.2. First directors to be appointed by subscribers. Sols.: Clifford-Turner and Co., 11 Old Jewry, London, E.C.2. Reg. off.: United Building, Trading Estate, Slough, Bucks.

OVERSEAS COMPANY

Olympic Airways S.A., Ltd. (F.4752).—Particulars filed Nov. 19, 1958, pursuant to Section 407 of the Companies Act, 1948. Cap.: $1,500,000 in 15,000 shs. of $100. Reg. in Greece in December, 1956, to operate all domestic and international air services, etc. British address: 150 New Bond St., London, W.1, where Constantine Xafolides is authorized to accept service of process and notices. Directors: Theodore Garofalides, Athens. Gerassimos Patronocolas, Athens. Constantine Konialides, Montevidio. Nicholas Konialides, Buenos Aires. Menelaos Tombias, Athens. Stavros Vassiliades, Athens.



AIDING PRODUCTION.—Staging built from slotted steel angle supplied by Handy Angle, Ltd., is used by Bristol Aircraft's Weston division in building Type 192 twin-rotor helicopters.

DUNLOP RUBBER.—A new type of oil-resistant silicone rubber, Silastic LS-53, is now being used by the Dunlop Rubber Co., Ltd., for various components in the aircraft industry. Silastic LS-53, a fluorinated silicone elastomer, is stated to be suitable for use in a wide range of aircraft oils and fuels, including mineral and synthetic di-ester lubricating oils, mineral and silicate-ester hydraulic oils, and petrol and kerosene type engine fuels.

Aviation Calendar

December 15.—R.Ae.S. All-day Discussion on Hypersonic Flow, at the Institution of Mechanical Engineers, Birdcage Walk, **London,** S.W.1, at 18.00 hrs.

December 15.—R.Ae.S. Henlow Branch lecture, "Medical Aspects of High Speed and Space Flight," by Wg. Cdr. W. A. Crawford, in Building 62, R.A.F. Technical College, **Henlow,** at 19.30 hrs.

December 17.—Institute of the Aeronautical Sciences, 22nd Wright Brothers Lecture, "Means and Examples of Aeronautical Research in France," by Maurice Roy (director, Office Nationale d'Etudes de Recherches Aéronautiques), at the Smithsonian Institution, **Washington, D.C.,** U.S.A.

December 17.—Aircraft Recognition Society, December Forum, in the R.Ae.S. Library, 4 Hamilton Place, **London** W.1, at 19.00 hrs.

December 17.—Kronfeld Club, Christmas Party, at 74 Eccleston Square, **London,** S.W.1.

December 17.—R.Ae.S. Guided Flight Section lecture, "Drone Aircraft," by H. G. Conway, at the Institution of Civil Engineers, Great George Street, **London,** S.W.1, at 18.00 hrs.

December 17.—R.Ae.S. Southend Branch, Helicopter film evening, at the Labour Hall, Boston Avenue, **Southend,** at 19.30 hrs.

December 18.—R.Ae.S. Main Lecture, "Air Traffic Control over the North Atlantic," by E. W. Pike, at the Institution of Mechanical Engineers, Birdcage Walk, **London,** S.W.1, at 18.00 hrs.

December 18.—R.Ae.S. Reading Branch lecture, "Servicing of Civil Aircraft," by J. Gregory in the canteen, Western Manufacturing, Ltd., **Reading,** at 18.15 hrs. **(instead of December 10).**

December 31.—Kronfeld Club, New Year's Eve Party, at 74 Eccleston Square, **London,** S.W.1.

SMOKING ALLOWED.—At this time of year there is always the nagging thought of presents to be found for a wide variety of friends and relatives. Fortunately, however wide the variety of persons involved, it is likely that cigarettes or, for the very fortunate, cigars, will make a particularly acceptable present. Once this is realized the gift problem becomes much easier. In the 1958 Christmas range of presentation packings of State Express 555 and other brands, you can count on finding just the thing, for when the "No Smoking" sign goes out.

AN ILLUSTRATED RECORD

THERE are more than 250 illustrations in the third edition of "THE AEROPLANE Pictorial Review," which has just been published by Temple Press Limited.

This record of aeronautical progress over the past year is suitable for aviation enthusiasts of all ages and covers every sphere of aviation. Containing 126 pp., 10 in. by 7½ in., this book can be obtained from booksellers, price 10s. 6d., or by post direct from the publishers at Bowling Green Lane, London, E.C.1, price 11s. 9d.

Birth Notices

Brown.—On November 30, at R.A.F. Hospital, Ely, to Audrey, wife of Flt. Lt. R. McN. Brown—a son.

Christie.—On November 21, at Farley House, Farnborough, Hants, to Joan (*née* Midgley), wife of Flt. Lt. A. M. Christie—a daughter.

Eden.—On November 26, at R.A.F. Hospital, Wegberg, to Winifred (*née* Mills), wife of Flt. Lt. Harry Eden—a son.

Green.—On November 25, at R.A.F. Hospital, Katunayake, Ceylon, to Cecily (*née* Archer), wife of Wg. Cdr. P. O. V. Green, A.F.C.—a daughter.

Hillyard.—On November 28, at R.A.F. Hospital, Halton, to Gwyn, wife of Sqn. Ldr. H. J. Hillyard—a son.

Neal.—On November 29, at Stroud Maternity Hospital, to Beryl (*née* Mapstone), wife of Flt. Lt. N. McD. Neal—a son.

Wood.—On November 23, at Edinburgh, to Flt. Lt. and Mrs. T. A. K. Wood (Edna Pennycook)—a son